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# COLUMBIA RIVER NUTRIENT STUDY - 1972

WASHINGTON STATE DEPARTMENT OF ECOLOGY

PREPARED FOR
ENVIRONMENTAL PROTECTION AGENCY

JULY 1975

167030

WORKING PAPER NO.
E.P.A.-910-9-75-011

PB 253 571

# COLUMBIA RIVER NUTRIENT STUDY IN COOPERATION WITH THE WASHINGTON STATE DEPARTMENT OF ECOLOGY AND THE OREGON STATE DEPARTMENT OF ENVIRONMENTAL QUALITY

ENVIRONMENTAL
PROTECTION
AGENCY
SURVEILLANCE AND
ANALYSIS DIVISION
SEATTLE, WASHINGTON
REGION X

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| BIBLIOGRAPHIC DATA SHEET | 1. Report No. EPA-910/9-75-011 | 2. | 3. Recipient's Accession No. PB-253571 |
|---|---|---|---|
| 4. Title and Subtitle<br>Columbia River Nutrient Study - 1972. | | | 5. Report Date<br>July, 1975<br>6. |
| 7. Author(s)<br>Jim Hileman, Richard Cunningham, Van Kollias | | | 8. Performing Organization Rept. No. |
| 9. Performing Organization Name and Address<br>Washington State Department of Ecology<br>Olympia, WA 98504 | | | 10. Project/Task/Work Unit No.<br>11. Contract/Grant No. |
| 12. Sponsoring Organization Name and Address<br>Surveillance and Analysis Division<br>U.S. Environmental Protection Agency<br>1200 Sixth Avenue<br>Seattle, WA 98101 | | | 13. Type of Report & Period Covered<br>Final report<br>14. |

15. Supplementary Notes

16. Abstracts This report assesses some water quality aspects of the Columbia River and its tributaries utilizing recent data from a one-year (11-01-71 to 10-31-72) cooperative survey. Participants in the survey included EPA, WA DOE, OR DEQ, USGS and some local agencies. The study was done to determine which tributaries to the main stem have the greatest adverse impact on the water quality of the Columbia River proper. The study period was divided into hydrologic quarters to differentiate between various discharge levels. Major nutrients (nitrogen and phosphorus), total coliform bacteria, temperature, pH and dissolved oxygen were measured. Sources and ambient concentrations of nitrate and orthophosphate received special attention. Although the survey yielded data on many other parameters, evaluation in this report is limited primarily to the nutrient constituents.

17. Key Words and Document Analysis. 17a. Descriptors

Water quality
Sampling
Chemical analysis
Nutrients
Temperature
Coliform bacteria
Stream pollution

17b. Identifiers/Open-Ended Terms

Columbia River
Snake River
Willamette River

17c. COSATI Field/Group 1.

PRICES SUBJECT TO CHANGE

| 18. Availability Statement | 19. Security Class (This Report) | 21. No. of Pages |
|---|---|---|
| Distribution unlimited. | UNCLASSIFIED | 82 |
| | 20. Security Class (This Page) UNCLASSIFIED | 22. Price $ 2.25 |

EPA 910/9-75-011
July, 1975

# COLUMBIA RIVER NUTRIENT STUDY - 1972

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## INTRODUCTION

The Columbia River and its tributaries comprise the most important river system in the Northwest. Its drainage basin area is approximately 259,000 square miles and includes Southeastern British Columbia; major portions of the states of Washington, Oregon, Idaho, and Montana; and small areas of Wyoming, Utah and Nevada. (Figures 1 and 2)

The degradation of Columbia River water quality is a real concern of Northwest citizens. Over the last 40 years they have watched a creeping change in the physical, chemical, and biological characteristics of the mainstem and its tributaries. In the mid 1930's the first major dams, Bonneville and Grand Coulee, were constructed on the Columbia River. These dams, and the many others constructed since, have had a profound influence on the river's physical and chemical characteristics and its native biota. Starting in the 1940's, the population in this river basin began a substantial increase, with a corresponding increase in municipal, industrial, and agricultural wastewater discharges.

These increased numbers of wastewater discharges, changes in the river's physical characteristics, increased algal growths, and other changes, have indicated the need for a comprehensive monitoring program on the entire river system. Specifically, there are concerns regarding summer water temperatures, reservoir eutrophication, increasing levels of toxic waste, cumulative effects of organic waste discharges from indistrial development and population growth, and high levels of dissolved gases.



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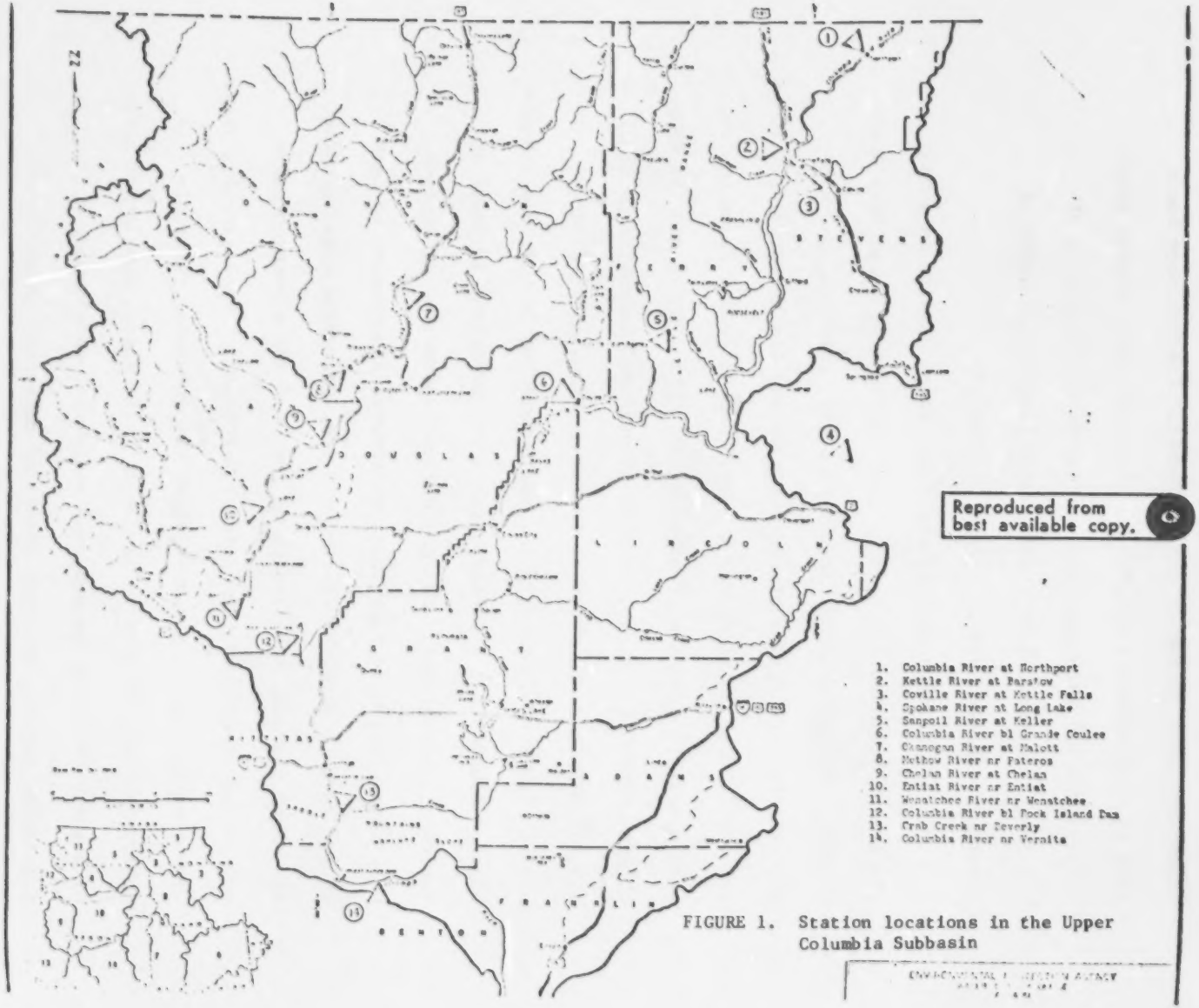
1. Columbia River at Northport
2. Kettle River at Barstow
3. Coville River at Kettle Falls
4. Spokane River at Long Lake
5. Sanpoil River at Keller
6. Columbia River bl Grande Coulee
7. Okanogan River at Malott
8. Methow River nr Pateros
9. Chelan River at Chelan
10. Entiat River nr Entiat
11. Wenatchee River nr Wenatchee
12. Columbia River bl Rock Island Dam
13. Crab Creek nr Beverly
14. Columbia River nr Vernita

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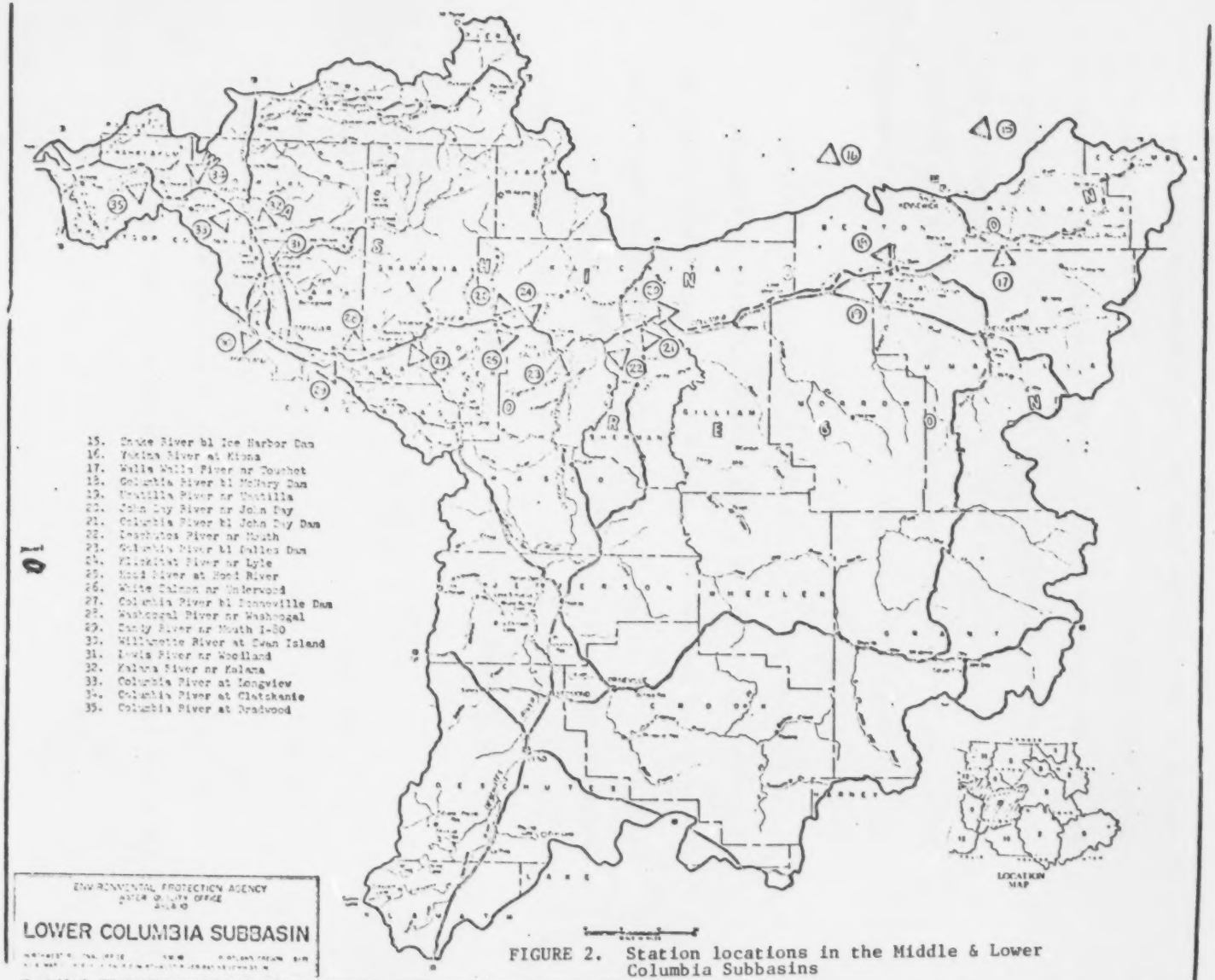
FIGURE 1. Station locations in the Upper Columbia Subbasin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29. Sandy River nr Mouth I-80
30. Willamette River at Swan Island
31. Lewis River nr Woodland
32. Kalama River nr Kalama
33. Columbia River at Longview
34. Columbia River at Clatskanie
35. Columbia River at Deadwood
LOCATION MAP
ENVIRONMENTAL PROTECTION AGENCY
LOWER COLUMBIA SUBBASIN

FIGURE 2. Station locations in the Middle & Lower Columbia Subbasins

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## SUMMARY

The purpose of this report is to assess some water quality aspects of the Columbia River and its tributaries utilizing recent data from a one-year (71-11-01 to 72-10-31) cooperative survey. The specific objective is to determine which tributaries to the main stem (Spokane, Yakima, etc.) had the greatest adverse influence on the Columbia River proper. Since water quality is influenced by discharge conditions, the study period was divided into hydrologic quarters (three month periods beginning 11-01-71) to differentiate between various discharge levels.

The parametric scope is limited to the major nutrients (nitrogen and phosphorus), total coliform bacteria, temperature, dissolved oxygen, and pH. Sources and ambient concentrations of nitrate and orthophosphate receive special attention because they are frequently related to a water's eutrophic state. Although the survey yielded data on many other parameters, evaluation in this report is limited primarily to the nutrient constituents.

## FINDINGS

1. Nutrient (total nitrogen and total phosphorus) loading levels in the Columbia River increased from the Canadian Border to the mouth. The relative degree of increased nutrient loading varied from 1.7 to 20.0 fold for total nitrogen and 2.3 to 11.0 fold for total phosphorus depending on hydrologic quarter.

2. The major proportion of nutrient loading in the Columbia River was directly attributable to tributary inputs. The Snake and Willamette Rivers together accounted for 56.5% to 80.2% of the total tributary nitrogen and 46.3% to 85.4% of the total tributary phosphorus to the Columbia River during quarterly periods.

3. Based on yearly average concentrations, orthophosphate-phosphorus exceeded 0.01 mg/l (critical level for algae bloom potential) at all Columbia River stations; nitrate-nitrogen exceeded 0.3 mg/l (critical level for algae bloom potential) at only one station (McNary Dam). Orthophosphate-phosphorus yearly average concentrations exceeded 0.01 mg/l at most tributary stations with the exceptions of the Kettle, Methow, Chelan, Entiat, and Wenatchee Rivers. Nitrate-nitrogen yearly average concentrations exceeded 0.3 mg/l at seven tributary stations; Crab Creek, Spokane, Yakima, Snake, Walla Walla, Umatilla, and Willamette Rivers.

Based on quarterly average concentrations, nitrate-nitrogen and orthophosphate-phosphorus exceeded the critical levels from November, 1971, to April, 1972, between river mile 292.0 and the mouth. Between May, 1972, and October, 1972, nitrate-nitrogen levels were limiting and orthophosphate-phosphorus levels were at minimum levels during the survey period.

4. Standards violations were observed at several Columbia River stations for temperature (river miles 734.5, 292.0, 215.6, 191.4, 145.3, 66.0, 53.5, and 38.9) and total coliforms (river miles 734.5, 66.0 and 38.9).

Recommendations

1. Further studies should be conducted in some of the tributaries, especially the Snake and Willamette Rivers, to better identify waste nutrient sources.

2. Data for other parameters included in this study should be evaluated, especially those for toxic metals.

3. All of the data should be used as a basis for design of a long term monitoring system.

4. An intensive bacteriological study is needed for the lower Columbia River to delineate the source or sources of apparent high bacterial densities.

5. A complete point source and non-point source waste inventory is needed for the lower Columbia River. Provisions should be made for continuous updating.

6. Additional parameters to be included for future studies of this type are algal assay, carbon-14 uptake, and chlorophyll determination.

## METHODS

To facilitate monitoring, the drainage basin was divided into two sections. The upper section included the mainstem and tributaries from McNary Dam (River Mile 292.0) to the International Border. The lower section included the waters downstream of McNary Dam to the mouth. Although the drainage basin was separated into two areas and investigated cooperatively by several agencies, every effort was made to insure that sample collection methods, sample collection schedules, and analytical procedures were similar.

### Upper Columbia

The upper Columbia River monitoring effort was coordinated by the Department of Ecology (DOE) with participation from U.S. Geological Survey (USGS), Walla Walla Health Department, and Benton-Franklin Health District. During May and June, additional assistance was provided by the Tri-County Air Pollution Control Authority during a temporary manpower shortage. The three local agencies confined their activities to sample collection in the Tri-City - Walla Walla area.

The Department of Ecology, in addition to coordinating the Upper River study in which samples were collected twice a month; collected all Upper River samples excluding those from the Tri-City - Walla Walla area. Sample analyses were shared among the agencies as shown in Table 1.

TABLE 1

UPPER RIVER LABORATORY
ANALYSES BY AGENCY

| | DOE | USGS | EPA |
|---|---|---|---|
| Conductivity | X | | |
| Turbidity | X | | |
| Color | X | | |
| $NH_3$ -N | | X | |
| $NO_2$ -N | | X | |
| $NO_3$ -N | | X | |
| TKjel-N | | X | |
| T-$PO_4$ | | X | |
| D Ortho-P | | X | |
| $BOD_5$ | X | | |
| TOC | | | X |
| TIC | | | X |
| TC (MF) | X | | |
| T Hard | | X | |
| Ca | | X | |
| Mg | | X | |
| Na | | X | |
| K | | X | |
| cl | | X | |
| SO | | X | |
| FC | X | | |
| Pesticides | | | X |
| Cu | | X | |
| Zn | | X | |
| Cr | | X | |
| Pb | | X | |
| T Hg | | X | |
| TDS | X | | |

Samples were collected using a bucket and line technique.

Temperature, pH and alkalinity, were determined immediately after collection. Dissolved oxygen samples were fixed on site and titrated at the end of the day. Trace metal and nutrient samples were preserved with concentrated $HNO_3$ and 4% $HgCl_2$ respectively and iced. Samples for coliform determinations were collected in sterilized containers and iced.

Coliform samples were shipped via Greyhound and analysis was initiated within 30 hours of sample collection. Nutrient samples were delivered to the USGS laboratory at the end of the survey run (not more than 3-1/2 days). EPA and ODEQ delivered samples to their respective labs with the exception of Total Organic Carbon (TOC) and bacteria samples which were shipped, via Greyhound bus, to the EPA laboratory. (See Table 2). Five-day BOD samples were collected only on Oregon Department of Environmental Quality (ODEQ) runs and analyzed by their laboratory.

Analytical methods utilized by the Washington Department of Ecology, Oregon Department of Environmental Quality, and Environmental Protection Agency laboratories are described in Standard Methods for the Examination of Water and Waste Water, 1971 and/or FWPCA Methods for Chemical Analysis of Water and Wastes, 1971. All analytical methods employed by USGS are described in Water Support Bulletin 1454 (1960).

TABLE 2. Lower river laboratory analyses by agency.

The following analytical tests were conducted by either ODEQ or EPA laboratories:

| Lab Analysis | ODEQ | EPA |
|---|---|---|
| TDS | X | X |
| Turbidity | X | X |
| Color | X | X |
| $NH_3$-N | X | X |
| $NO_2$-N | X | X |
| $NO_3$-N | X | X |
| T Kjel-N | X | X |
| T Phos-P | X | X |
| D Phos-P | X | X |
| D Ortho-P | X | X |
| $BOD_5$ | X | |
| TOC | | X |
| TIC | | X |
| TC | | X |
| PBl | X | X |
| T Hard | X | X |
| T Ca | X | X |
| T Mg | X | X |
| D Na | X | X |
| D K | X | X |
| Cl | X | X |
| $SO_4$ | X | X |
| T As | X | X |

Table 2 (Cont'd)

| Lab Analysis | ODEQ | EPA |
|---|---|---|
| T Cd | X | X |
| T Cr | X | X |
| T Hg | X | X |
| T Cu | X | X |
| T Fe | X | X |
| T Pb | X | X |
| T Zn | X | X |
| T Sb | X | X |
| T Se | X | X |
| T Coli (MF) | | X |
| F Coli (MF) | | X |

## Lower Columbia

The Lower Columbia River monitoring program was shared by the Oregon Department of Environmental Quality (ODEQ) and Region X of the Environmental Protection Agency (EPA) with participation from the Oregon District U.S. Geological Survey.

The U.S. Geological Survey installed staff gages and developed flow rating curves for several of the tributaries so that nutrient loading values could be determined.

The ODEQ and EPA collected all samples in the Lower Columbia River reach on a bi-weekly basis. Each agency's field personnel conducted the monitoring run during alternate two week periods.

Sample collection and field analysis techniques employed by EPA and ODEQ were similar to those used by DOE.

## DISCUSSION

This section will be devoted to an interpretation of hydrology, nutrient loading levels, water quality standards criteria violations, and nutrient levels for the main stem Columbia River and tributary stations. Nutrient loadings, nutrient levels, temperature, and total coliforms will be delineated by hydrologic quarters: hydrologic quarter 1: 11-01-71 to 01-31-72, hydrologic quarter 2: 02-01-72 to 04-30-72, hydrologic quarter 3: 05-01-72 to 07-31-72, hydrologic quarter 4: 08-01-72 to 10-30-72.

### Hydrology

Columbia River flow is characterized by two peaks per year. The spring peak, usually maximum in June, is due to snow melt in the mountainous parts of the drainage basin. The winter peak can occur from December through March and is primarily caused by precipitation and flooding in the tributaries west of the Cascade Range" (Haertet, Osterberg, Curl, and Park, 1969). Extremes encountered during the course of this study were 651,000 cfs on 72-06-15 to 27 and 164,300 cfs on 72-09-21 to 25 at river mile 38.9.

A seasonal comparison of Columbia River flows at the furthermost upstream station (river mile 734.5) and near the mouth (river mile 38.9) appears in Table 8.

Table 3 - Seasonal Comparison of Columbia River Flows

| Station | Quarter 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| River Mile 734.5 | 88,600 | 65,568 | 237,000 | 97,000 |
| River Mile 38.9 | 312,620 | 483,700 | 492,000 | 185,000 |
| Difference* | 224,000 | 418,000 | 255,000 | 88,000 |

* Due to tributaries, runoff, and groundwater inflow.

Flow profiles of the river for each quarter appear in Figures 3 and 4. In some instances, the river flow appears to decrease in the downstream direction between two stations. Such apparent decreases are generally artifacts of the data collection method. Daily average flows were available for some stations and only instantaneous flows at sampling time for others. Although such flow records are not directly comparable, they are the best available.

The average increase in flow between river miles 734.5 and 38.9 was greatest during quarter #2. This suggests that the water quality impact of tributary, runoff, and groundwater inflow on the Columbia River would also be greatest during this quarter.

During quarter #3, flow at river mile 734.5 averaged substantially higher than for quarters 1, 2 and 4. Moderate downstream inflows coupled with high flows at river mile 734.5 produced the largest average quarterly flows at all Columbia River stations during this quarter.

Nutrient Loadings

Nutrient loading (total nitrogen and phosphorus) in the Columbia River is in a constant state of change. Complicated variables such as rainfall, snow melt, industrial and agricultural activity all exert their influence in varying degrees. Generally speaking, the largest source of nutrient loading in the Columbia River is the tributary inputs of Washington and Oregon, but even this is not always the case.

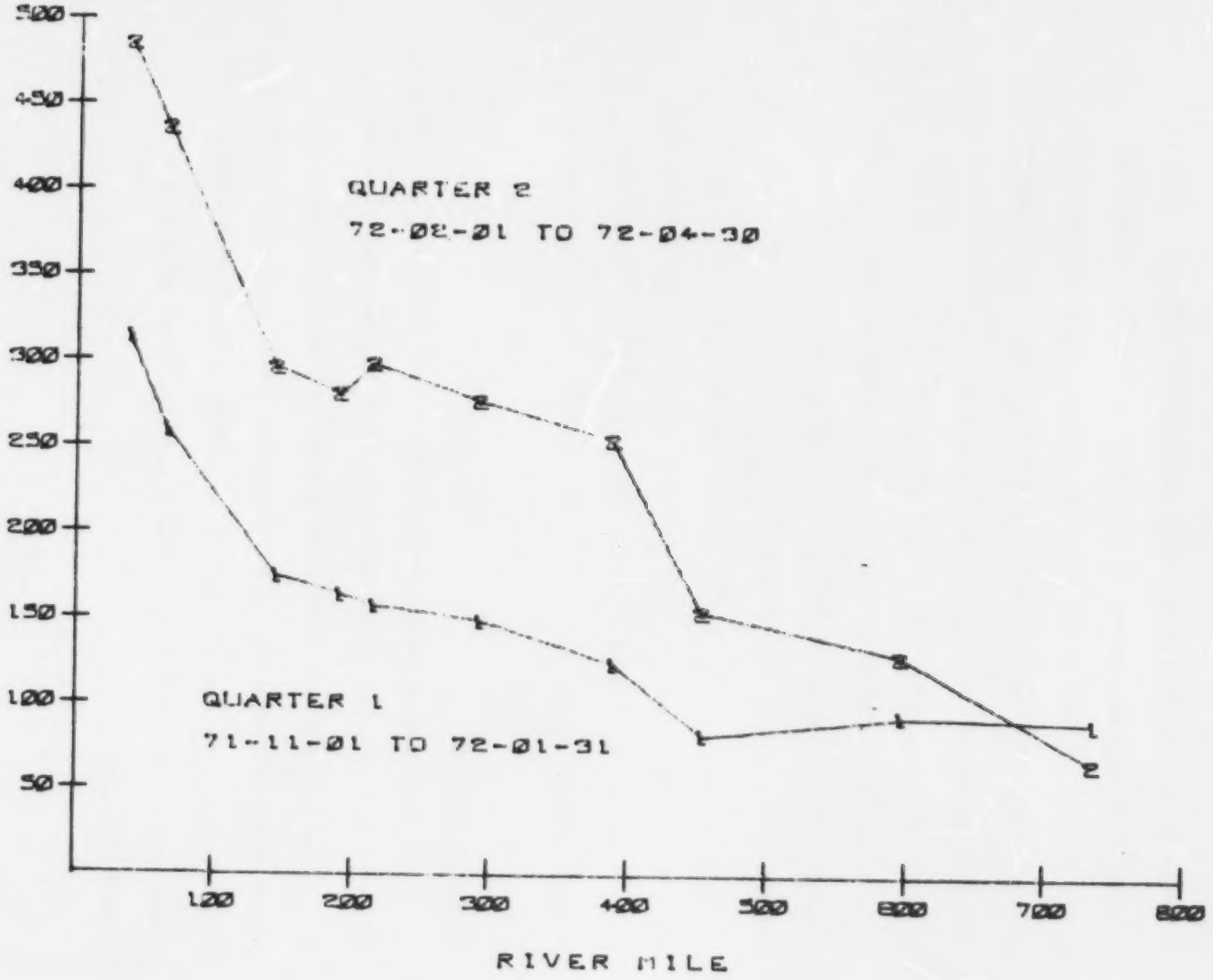


FIGURE 3 FLOW IN THE COLUMBIA RIVER AS A FUNCTION OF RIVER MILE

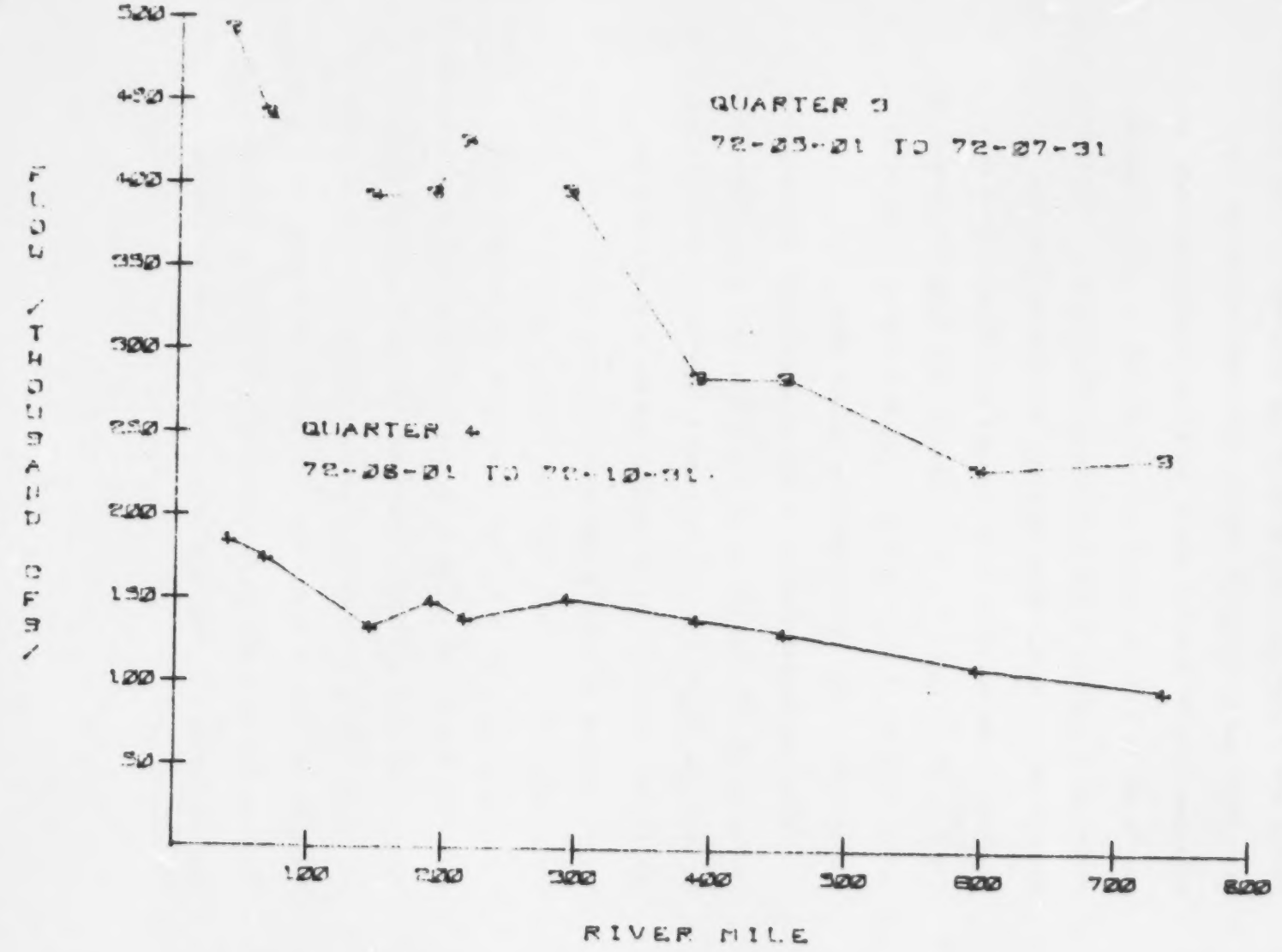


FIGURE 4 FLOW IN THE COLUMBIA RIVER AS A FUNCTION OF RIVER MILE

Quarter #1 - Total nitrogen loading in the Columbia River increased from 163,000 to 1,470,000 lbs/day, or by 9 times, from river miles 734.5 (near the Canadian Border) to 38.9 (near the mouth) (See Figure 5). Two thirds of the increase (873,000 lbs/day) was attributed to tributary inputs. The remaining excess total nitrogen (434,000 lbs/day) cannot be explained by this study, but may be due to such factors as diffuse sources, nitrogen-fixation, variation in analytical and sampling techniques, etc. Correlation between cumulative tributary loadings and loadings actually measured in the Columbia River was very good between river miles 734.5 to 73.1 (Figure 3). The Willamette and Snake Rivers were the largest sources of total nitrogen, contributing 54.8% and 25.4% respectively of the total tributary loading (Table 4).

Total phosphorus loading in the Columbia River increased from 26,000 to 191,000 lbs/day, or by 7.4 times, from river miles 734.5 to 38.9 (See Figure 6). The increase attributed to tributary inputs was 121,000 lbs/day. The Willamette and Snake Rivers were the largest sources of total phosphorus; contributing 68.9% and 16.5% respectively of the total tributary loading (Table 5).

Quarter #2 - Total nitrogen loading in the Columbia River increased from 97,000 to 1,951,000 lbs/day, or by 20 times, between river miles 734.5 and 38.9. Tributary loading (1,356,000 lbs/day) to the Columbia River reached a maximum during this quarter. The Snake and Willamette Rivers were the largest sources of total nitrogen contributing 49.7% and 22.3% respectively of the total tributary loading (Table 4). The correlation between tributary loading and

TOTAL NITROGEN

| Ranking | River | * Percent (%) | lbs/day |
|---|---|---|---|
| 1 | Willamette | 54.8 | 478591 |
| 2 | Snake | 25.4 | 221671 |
| 3 | Yakima | 3.3 | 28723 |
| 4 | Spokane | 3.1 | 27512 |
| 5 | Lewis | 3.0 | 26125 |
| 6 | Deschutes | 1.8 | 15292 |
| | | | |
| 1 | Snake | 49.7 | 674533 |
| 2 | Willamette | 22.3 | 302072 |
| 3 | John Day | 6.8 | 92585 |
| 4 | Spokane | 6.1 | 82780 |
| 5 | Yakima | 3.7 | 50485 |
| 6 | Umatilla | 3.0 | 40765 |
| | | | |
| 1 | Snake | 44.3 | 286947 |
| 2 | Willamette | 12.2 | 79359 |
| 3 | Spokane | 7.0 | 45771 |
| 4 | Okanogan | 6.8 | 44247 |
| 5 | Yakima | 6.3 | 40738 |
| 6 | Wenatchee | 5.1 | 33531 |
| | | | |
| 1 | Snake | 36.3 | 85921 |
| 2 | Willamette | 12.2 | 60574 |
| 3 | Deschutes | 6.3 | 14895 |
| 4 | Yakima | 6.3 | 14831 |
| 5 | Spokane | 6.2 | 14628 |
| 6 | Okanogan | 3.7 | 8765 |
| 7 | Wenatchee | 3.1 | 7272 |

* % of total tributary loading

TABLE 4

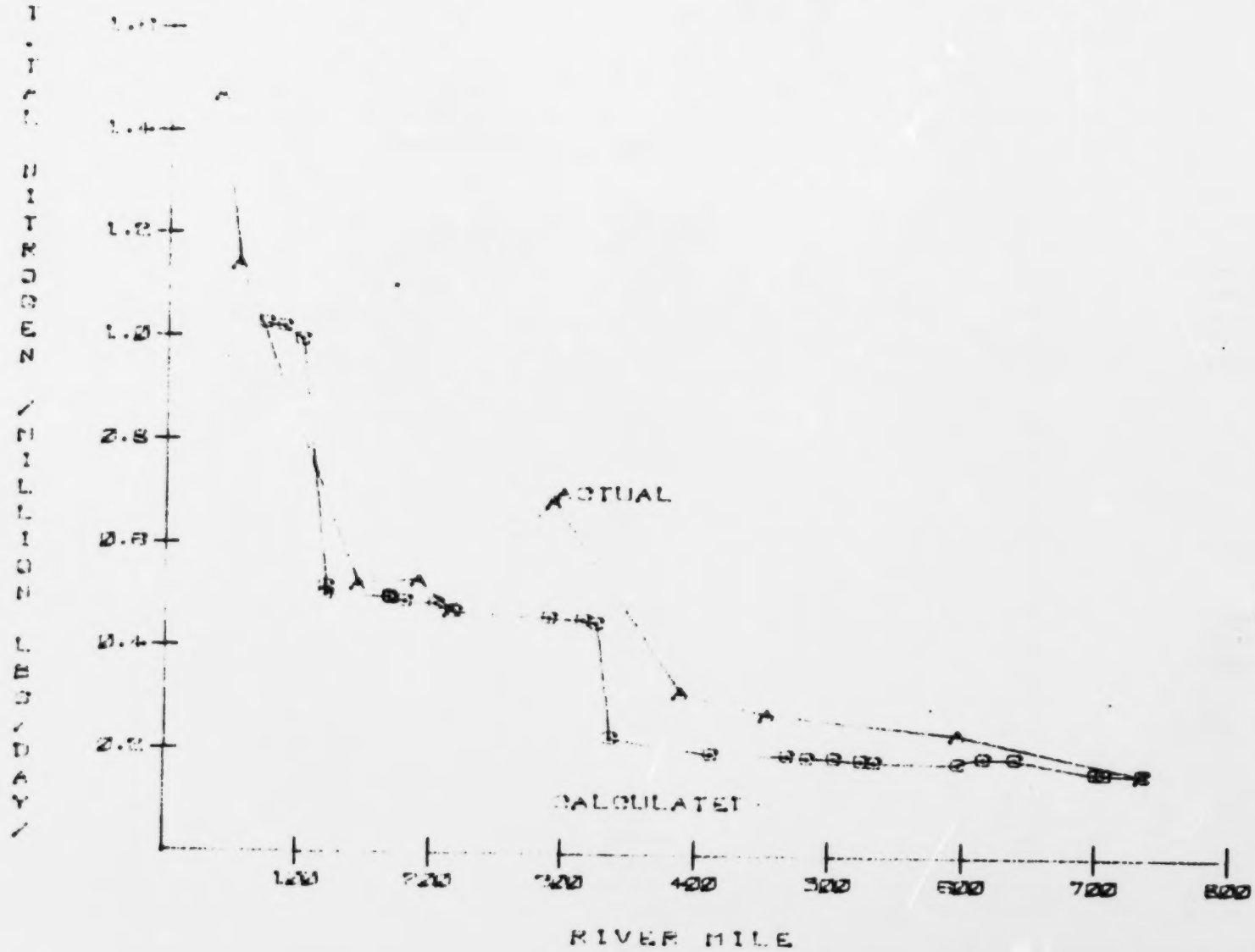


FIGURE 5 COMPARISON OF ACTUAL AND CALCULATED TOTAL NITROGEN LOADING IN THE COLUMBIA RIVER- QUARTER 1

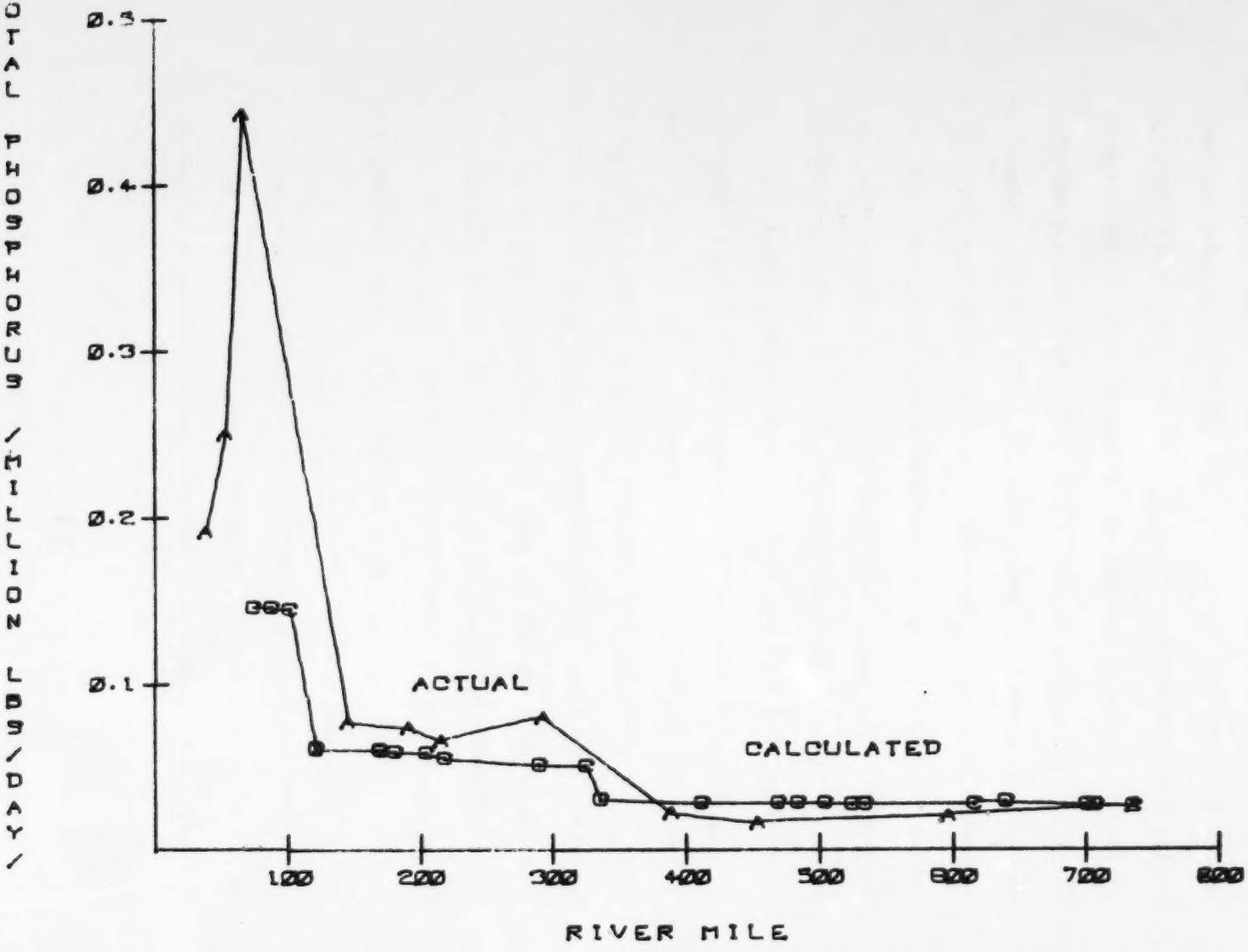


FIGURE 6 COMPARISON OF ACTUAL AND CALCULATED TOTAL PHOSPHORUS LOADING IN THE COLUMBIA RIVER- QUARTER 1

actual Columbia River loading was not as good as for the first quarter (Figure 7).

Total phosphorus loading in the Columbia River increased from 18,000 to 199,000 lbs/day, or by 11 times, between river miles 734.5 and 38.9. Tributary loading (257,000 lbs/day) reached a maximum during this quarter (See Figure 8). In this case, total tributary loading exceeded the increase of loading observed in the Columbia River by 42%. Again, as stated previously, many factors may influence the observed values. Also, the survey was not designed to delineate this type of variation. However, the general correlation between tributary and actual Columbia River loadings was good (Figure 8). The Snake, Willamette, and John Day Rivers were the largest sources of total phosphorus contributing 26.7%, 19.6% and 17.5% respectively of the total tributary loading (Table 5).

Quarter #3 - Total nitrogen loading in the Columbia River increased from 662,000 to 1,112,000 lbs/day, or by 1.7 times, between river miles 734.5 and 38.9 (Figure 9). The increase attributed to tributary inputs was 657,000 lbs/day. The Snake and Willamette Rivers were the largest sources of total nitrogen contributing 44.3% and 12.2% respectively of the total tributary loading (Table 4). The Columbia River at river mile 734.5 reached a maximum average loading (662,000 lbs/day) and a maximum average flow (240,000 cfs) during this quarter.

Total phosphorus loading in the Columbia River increased from 39,000 to 203,000 lbs/day, or by 5.2 times, between river miles 734.5 and 38.9 (Figure 10). The increase attributed to tributary

TOTAL PHOSPHORUS

| Ranking | River | *Percent (%) | lbs/day |
|---|---|---|---|
| 1 | Willamette | 68.9 | 83444 |
| 2 | Snake | 16.5 | 19953 |
| 3 | John Day | 3.1 | 3810 |
| 4 | Deschutes | 2.9 | 3506 |
| 5 | Spokane | 1.8 | 2130 |
| 6 | Yakima | 1.6 | 1934 |
| | | | |
| 1 | Snake | 26.7 | 68745 |
| 2 | Willamette | 19.6 | 50453 |
| 3 | John Day | 17.5 | 45071 |
| 4 | Lewis | 9.7 | 25030 |
| 5 | Umatilla | 8.0 | 20501 |
| 6 | Spokane | 5.3 | 13639 |
| 7 | Yakima | 4.8 | 12446 |
| | | | |
| 1 | Snake | 44.9 | 34615 |
| 2 | Okanogan | 15.7 | 12157 |
| 3 | Yakima | 9.3 | 7188 |
| 4 | Willamette | 8.2 | 6354 |
| 5 | Spokane | 5.7 | 4404 |
| 6 | Methow | 4.8 | 3691 |
| | | | |
| 1 | Willamette | 30.1 | 4967 |
| 2 | Snake | 28.1 | 4643 |
| 3 | Deschutes | 12.9 | 2127 |
| 4 | Yakima | 9.3 | 1534 |
| 5 | Spokane | 5.6 | 928 |
| 6 | Klickitat | 2.3 | 381 |

* % of total tributary loading

TABLE 5

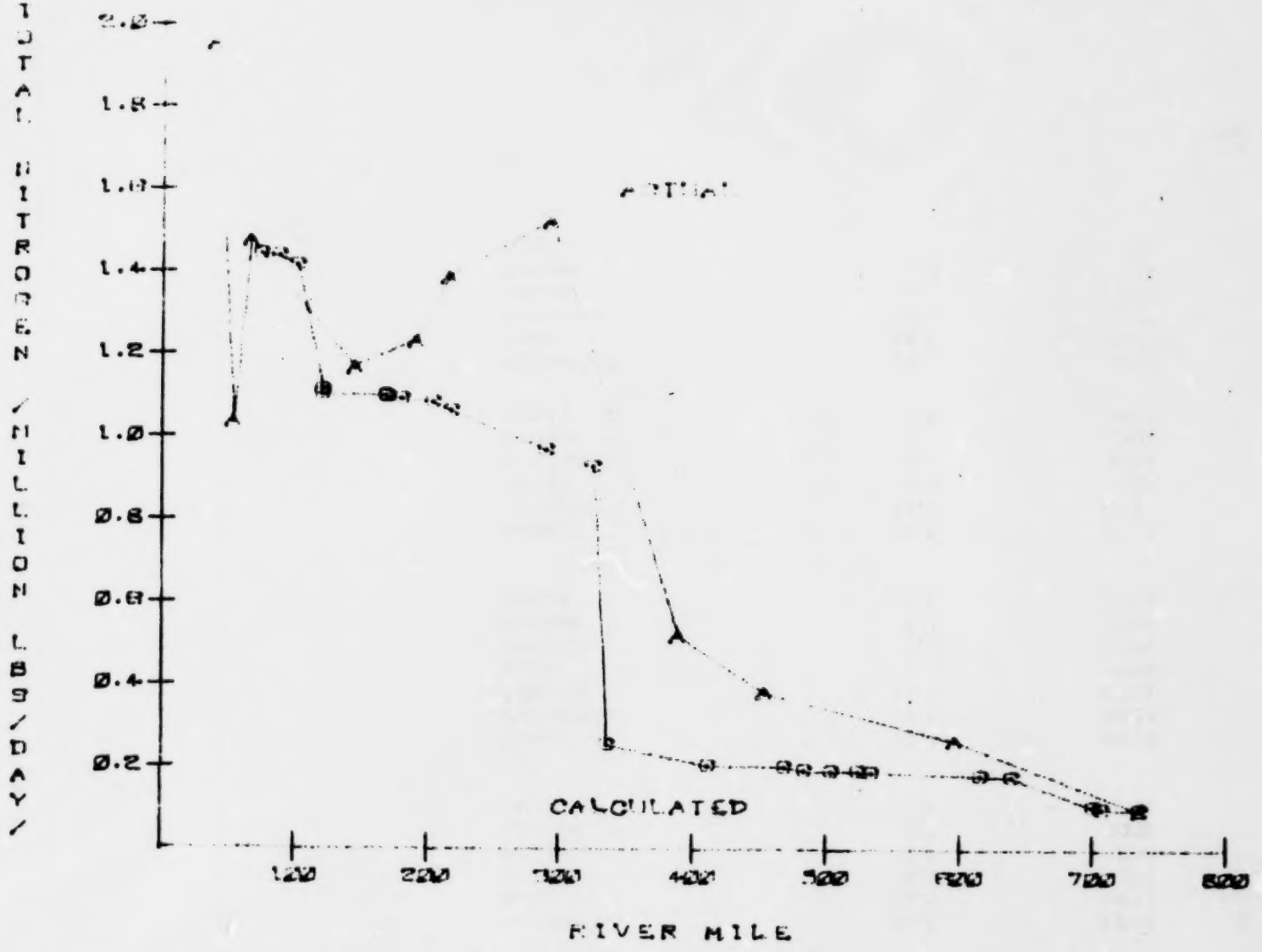


FIGURE 7 COMPARISON OF ACTUAL AND CALCULATED TOTAL NITROGEN LOADING IN THE COLUMBIA RIVER- QUARTER 2

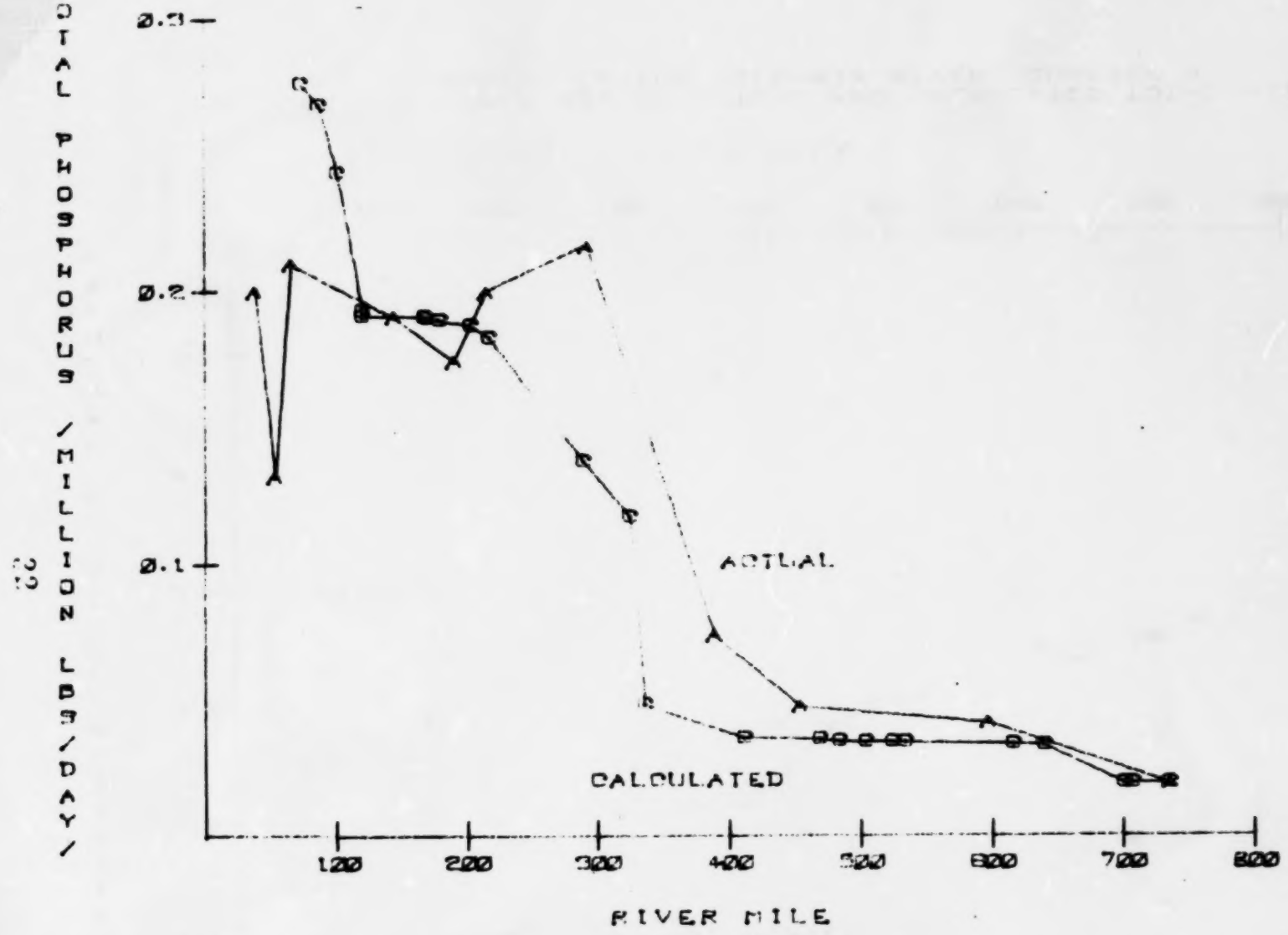


FIGURE 8 COMPARISON OF ACTUAL AND CALCULATED TOTAL PHOSPHORUS LOADING IN THE COLUMBIA RIVER- QUARTER 2

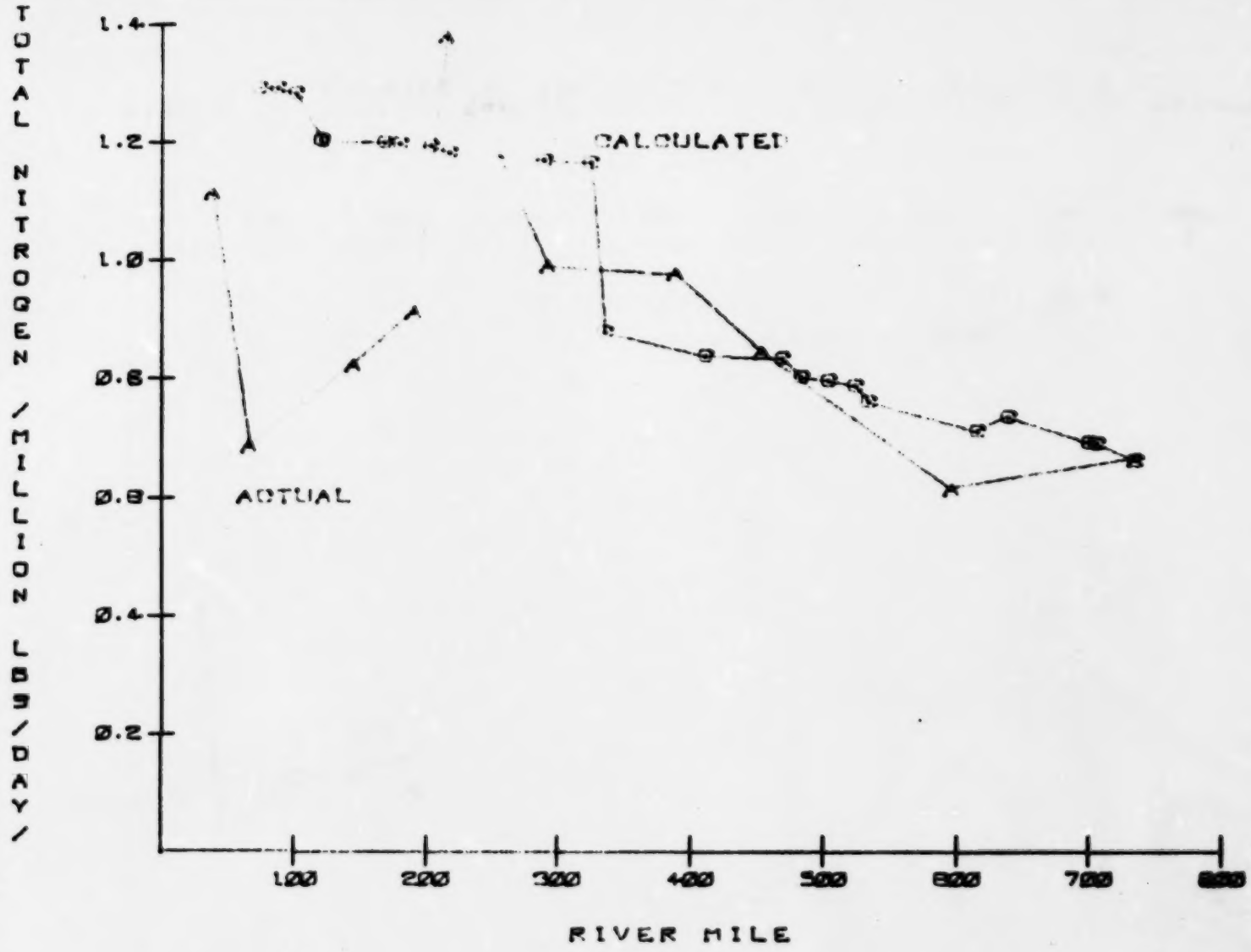


FIGURE 8 COMPARISON OF ACTUAL AND CALCULATED TOTAL NITROGEN LOADING IN THE COLUMBIA RIVER- QUARTER 3

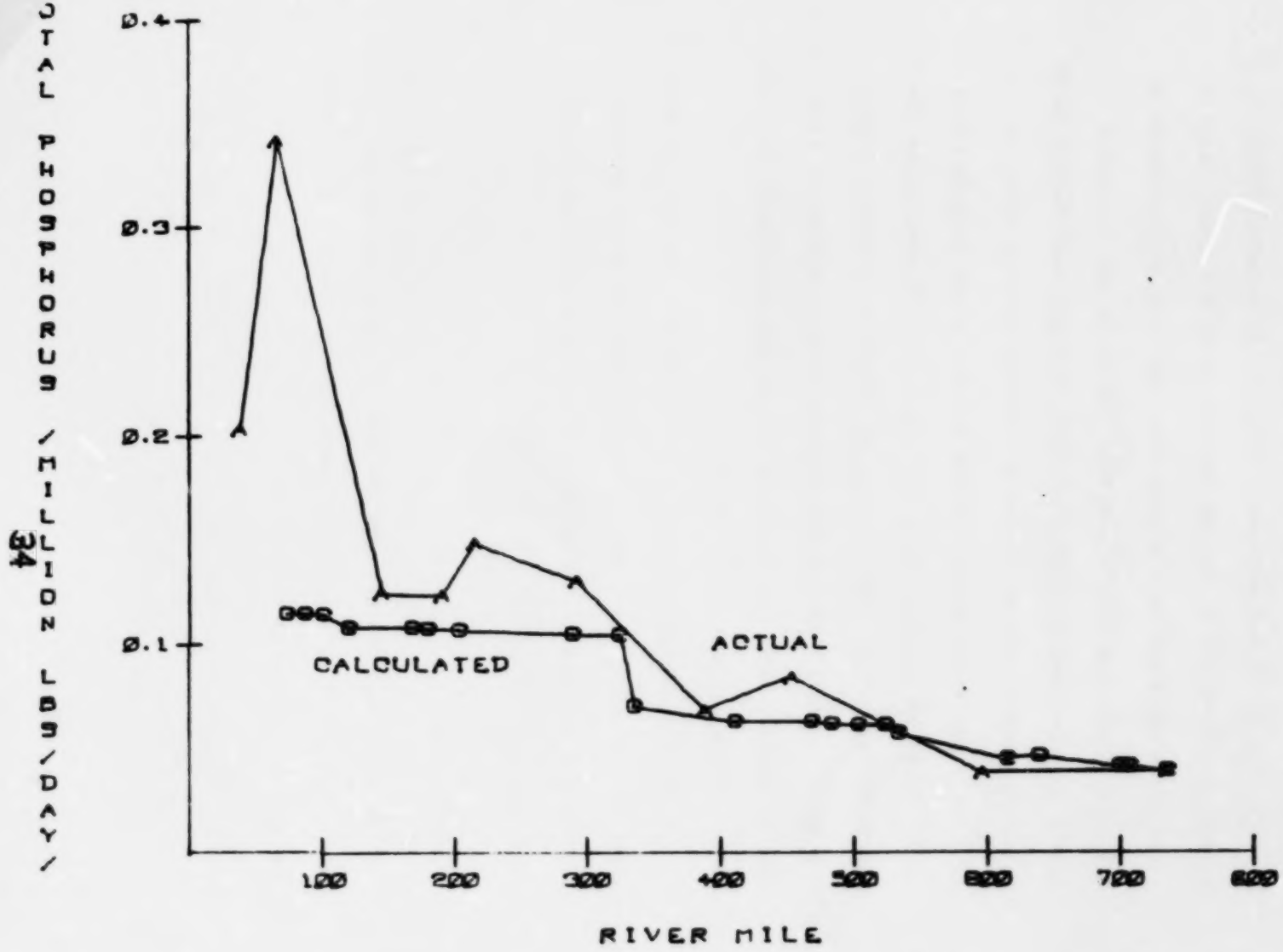


FIGURE 10 COMPARISON OF ACTUAL AND CALCULATED TOTAL PHOSPHORUS [illegible] IN THE COLUMBIA RIVER- QUARTER 3

inputs was 77,000 lbs/day. The largest sources of total phosphorus were the Snake and Okanogan Rivers, contributing 44.9% and 15.7% respectively (Table 5). The Willamette River (8.2%) dropped to fourth place behind the Yakima River (9.3%) during this quarter.

Quarter #4 - Total nitrogen loading in the Columbia River increased from 91,000 to 622,000 lbs/day, or by 6.4 times, between river miles 734.5 and 38.9 (Figure 11). The increase attributed to tributary inputs was 657,000 lbs/day. The Snake and Willamette Rivers were the largest sources of total nitrogen contributing 36.3% and 25.6% respectively of the total tributary loading (Table 4).

Total phosphorus loading in the Columbia River increased from 18,000 to 42,000 lbs/day, or by 2.3 times, between river miles 734.5 and 38.9 (Figure 12). The increase attributed to tributary inputs was 16,500 lbs/day. The largest sources of total phosphorus were the Willamette, Snake and Deschutes Rivers contributing 30.1%, 28.1% and 12.9% respectively (Table 5).

Tributary nutrient loading to the Columbia River averaged much lower during this quarter than during the previous three quarters. Tributary flow input to the Columbia River was also lowest during this quarter.

## Nutrient Levels

Nutrient (nitrate-nitrogen and orthophosphate-phosphorus levels in the Columbia River are summarized by yearly and quarterly averages in Figures 13 through 18.

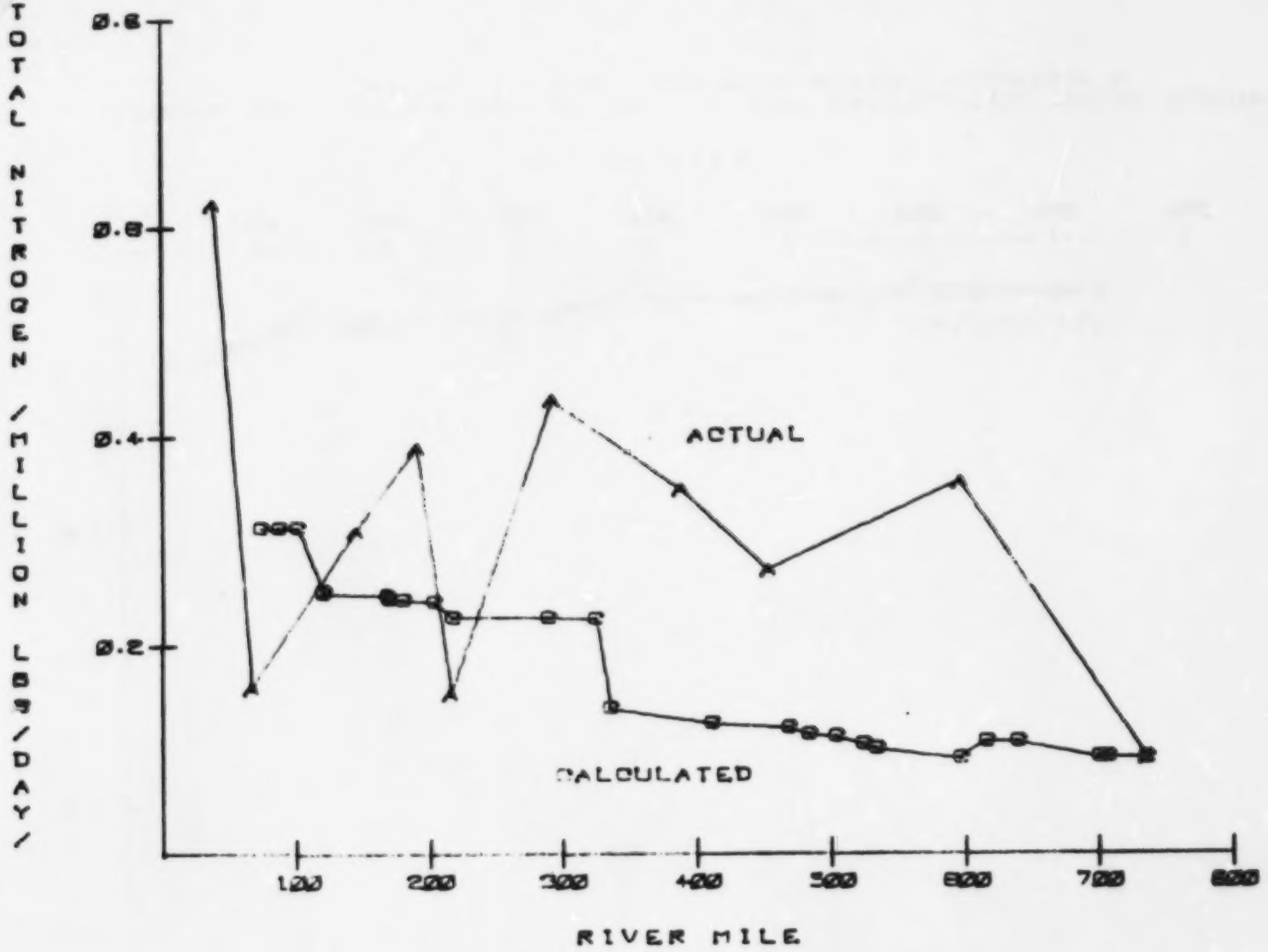


FIGURE 11 COMPARISON OF ACTUAL AND CALCULATED TOTAL NITROGEN LOADING IN THE COLUMBIA RIVER- QUARTER 4

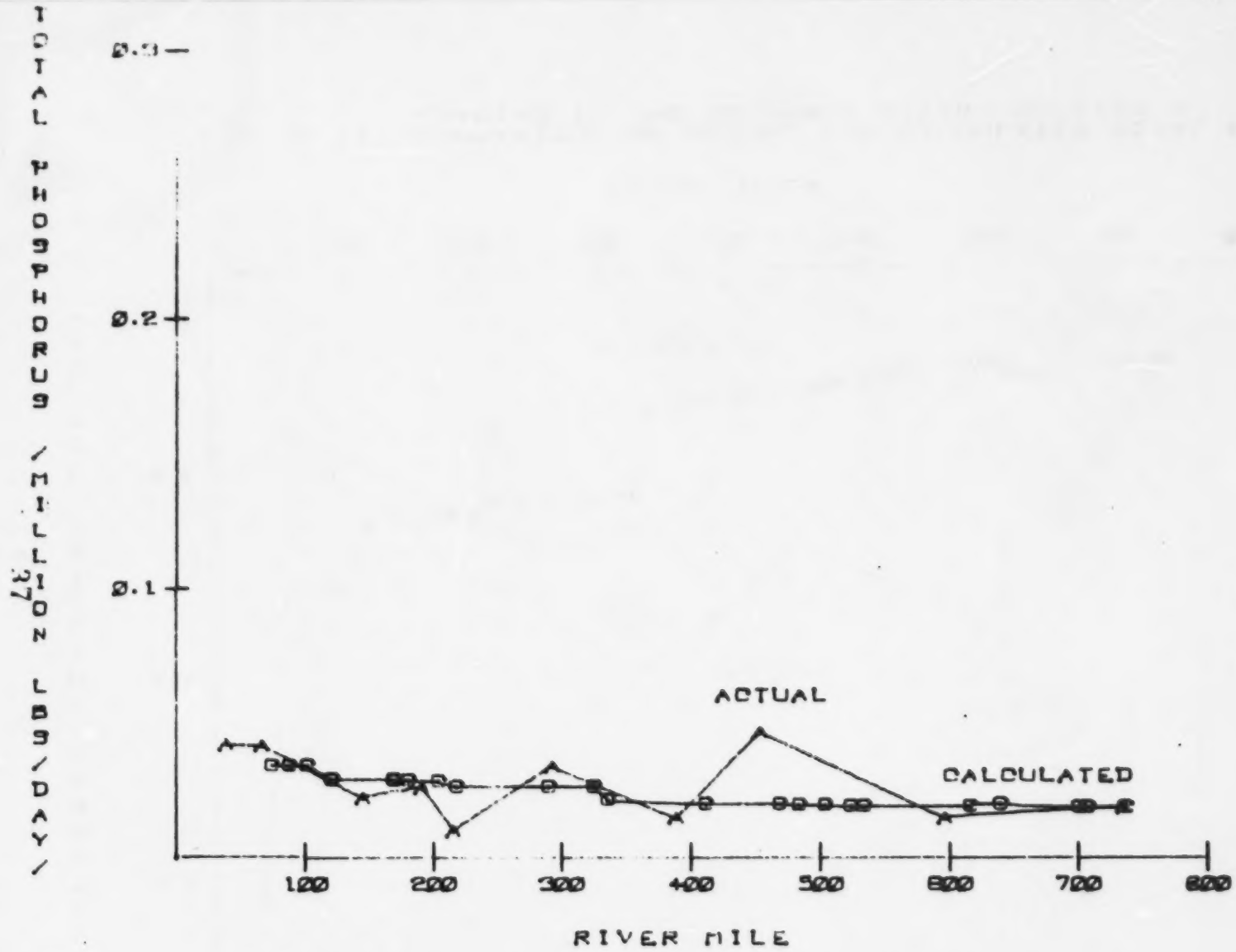


FIGURE 12 COMPARISON OF ACTUAL AND CALCULATED TOTAL PHOSPHORUS LOADING IN THE COLUMBIA RIVER- QUARTER 4

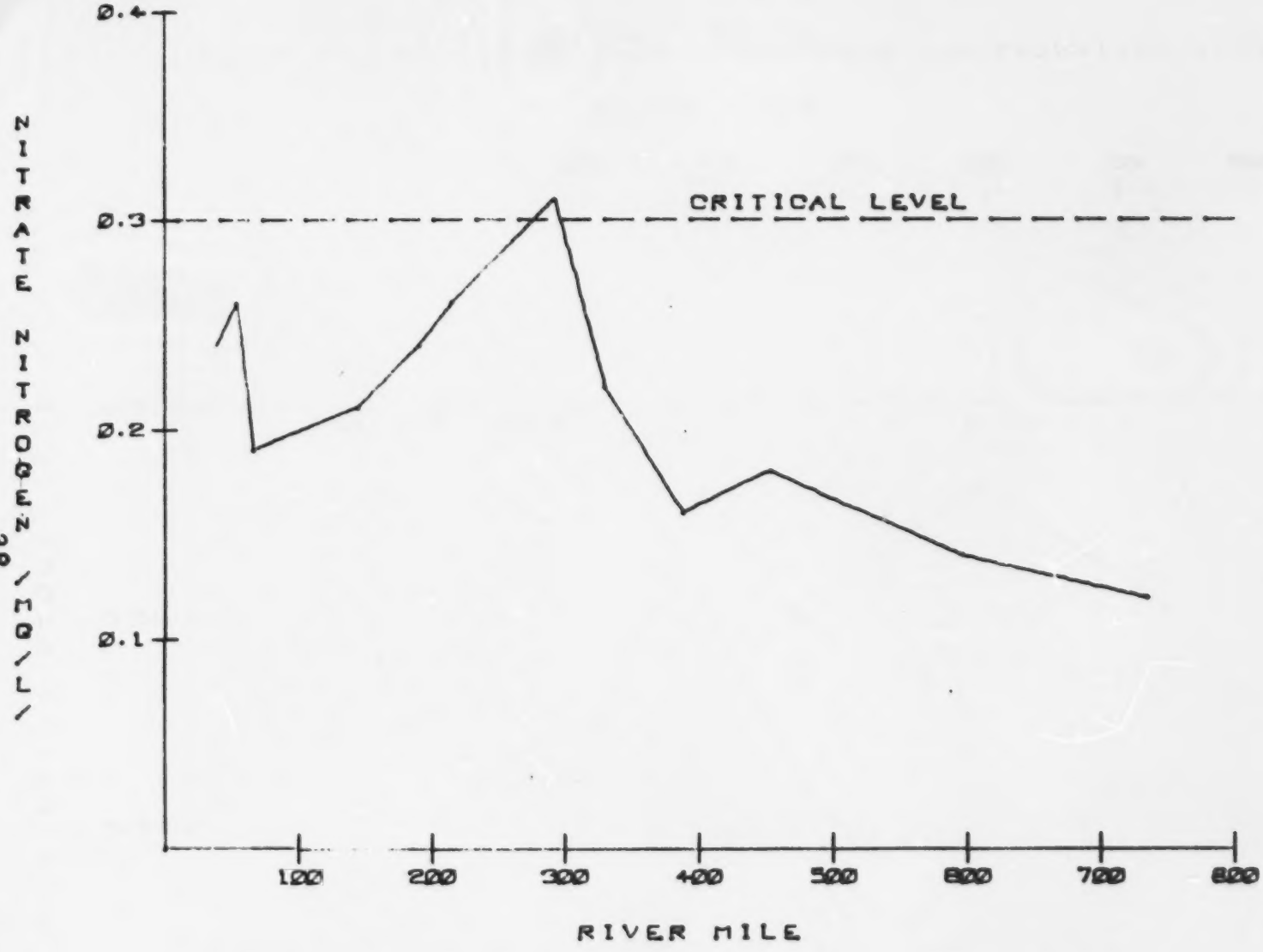


FIGURE 13 NITRATE-NITROGEN CONCENTRATION (YEARLY AVG) IN THE COLUMBIA RIVER

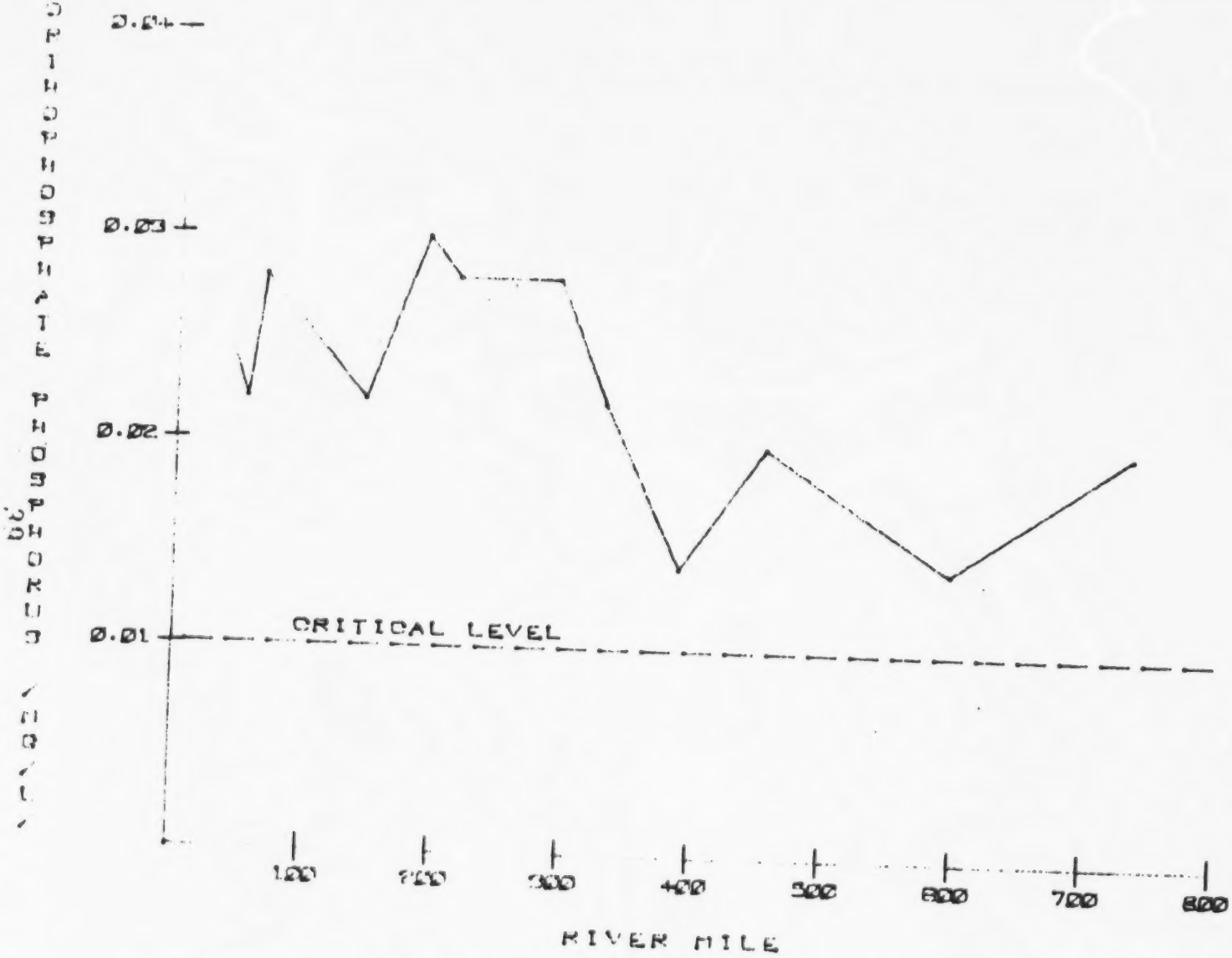


FIGURE 14 ORTHOPHOSPHATE-PHOSPHORUS CONCENTRATION (YEARLY AVG) IN THE COLUMBIA RIVER

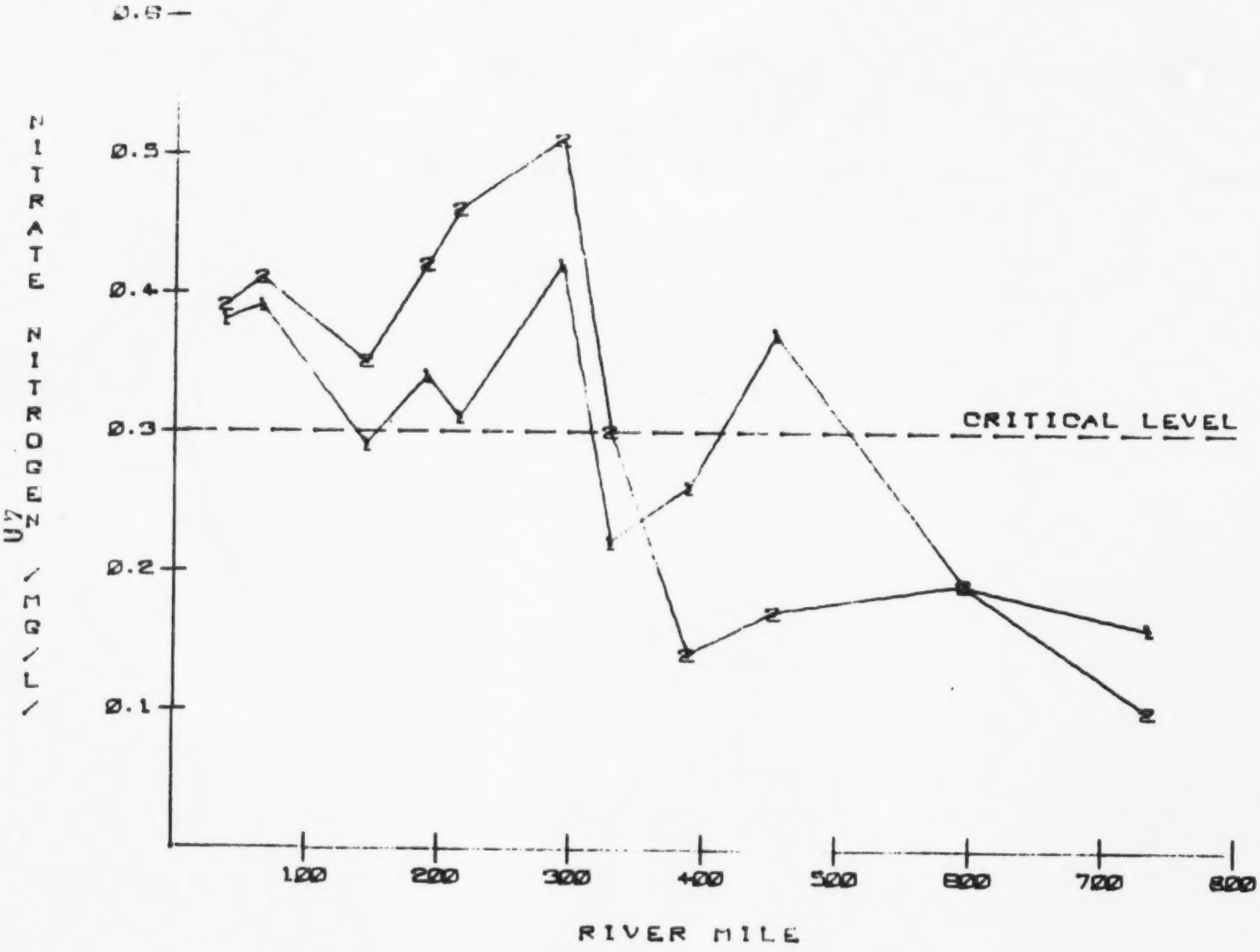


FIGURE 15 QUARTERLY AVG CONCENTRATION OF NITRATE-NITROGEN (QUARTERS 1 AND 2)

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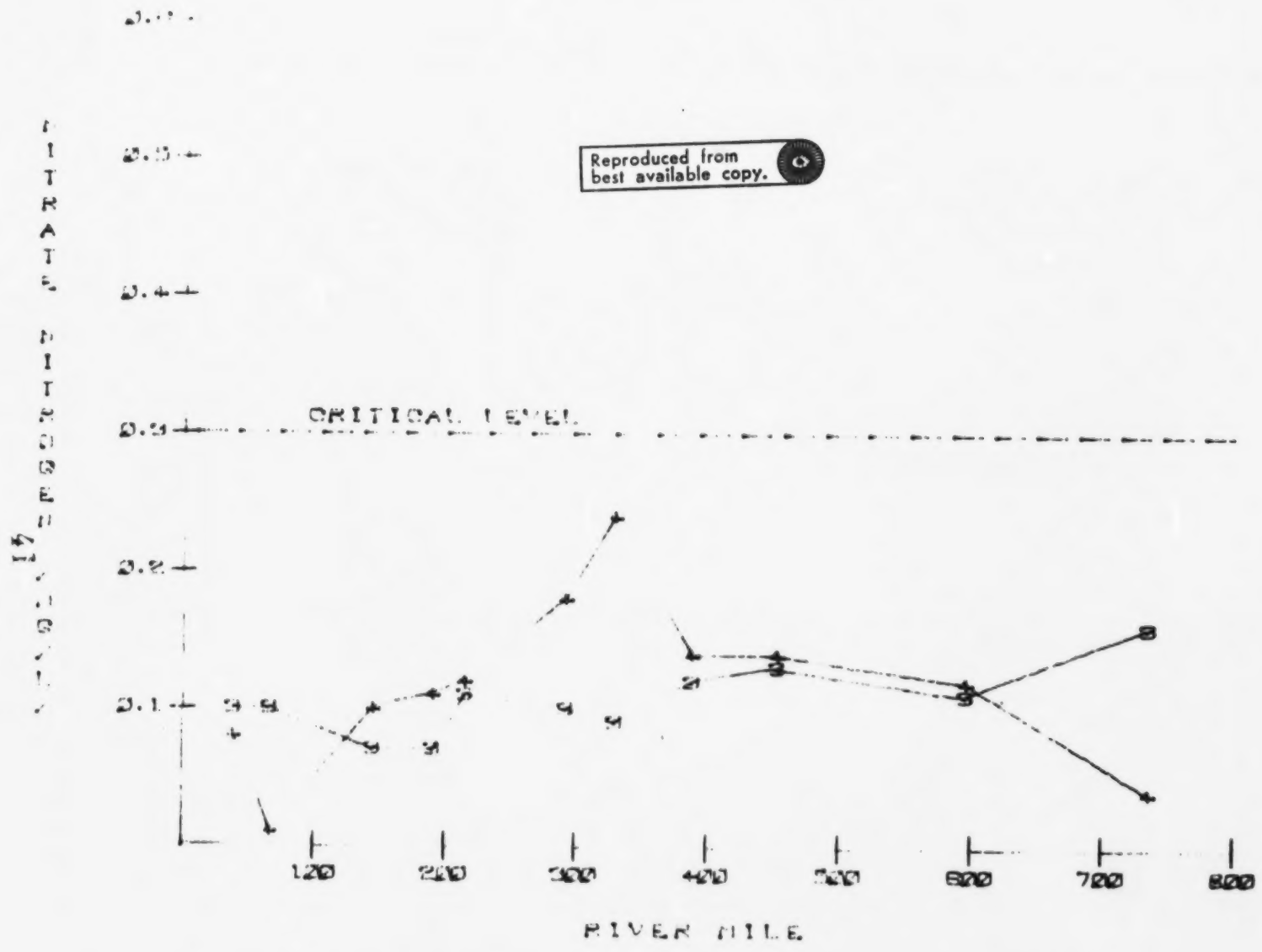


FIGURE 18 SUMMER AVERAGE CONCENTRATION OF NITRATE-NITROGEN (SUMMERS 3 AND 4)

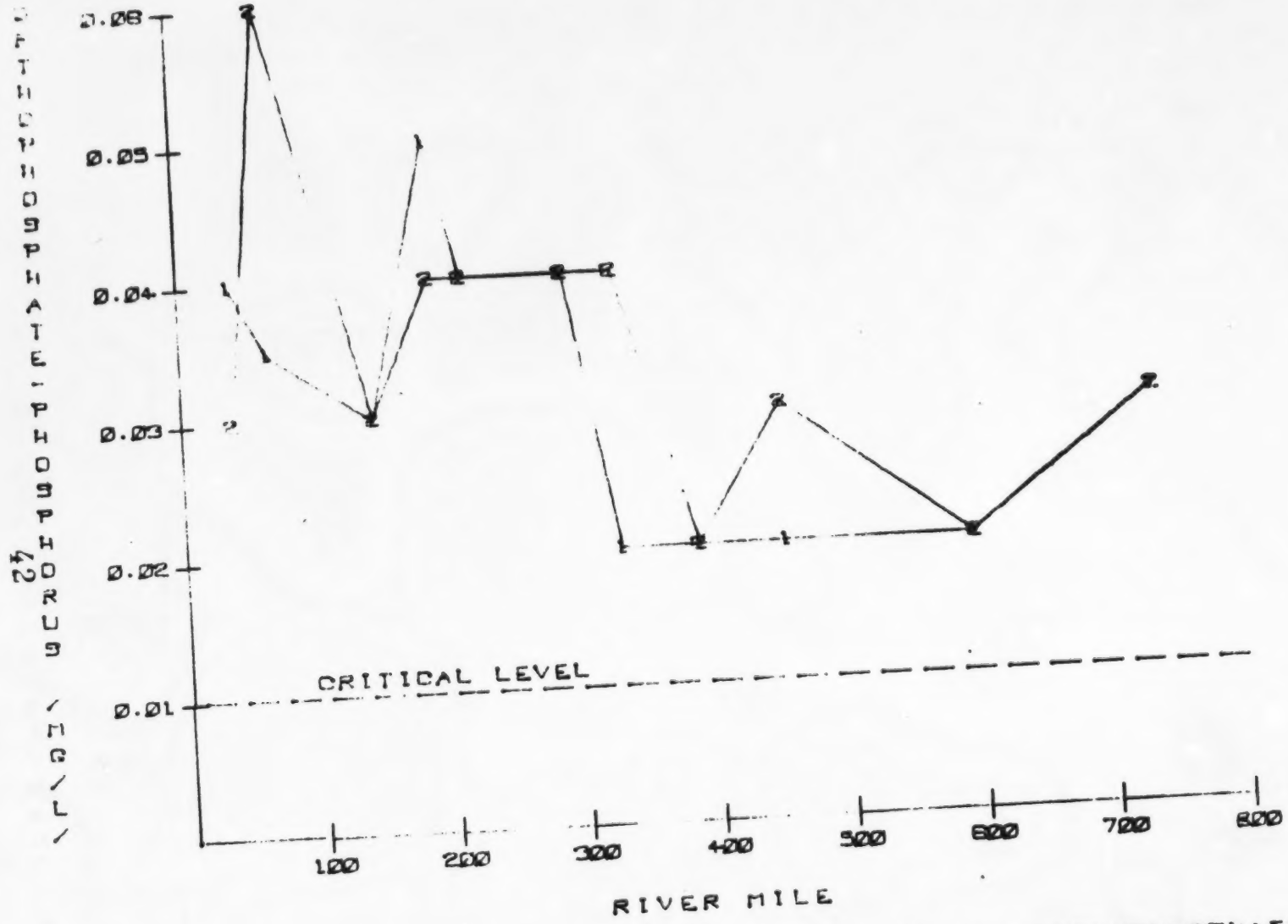


FIGURE 17 QUARTERLY AVG CONCENTRATION OF ORTHOPHOSPHATE-PHOSPHORUS (QUARTERS 1 AND 2)

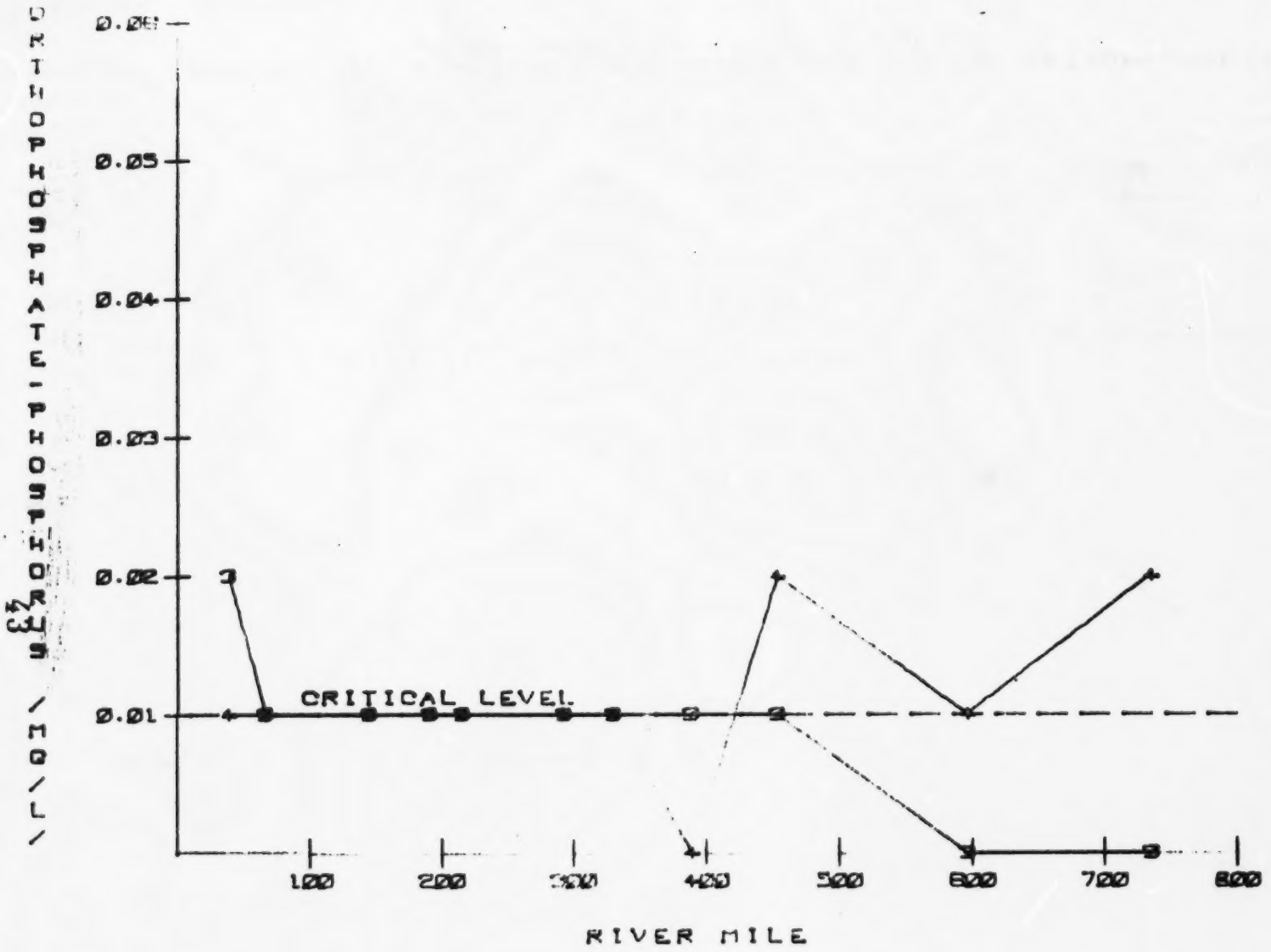


FIGURE 18 QUARTERLY AVG CONCENTRATION OF ORTHOPHOSPHATE-PHOSPHORUS (QUARTERS 3 AND 4)

Nitrate-nitrogen concentrations were observed above the critical level (.3 mg/l) at all mainstem Columbia River stations (Table 6). The frequency in excess of the critical level was found to be substantially less than that for orthophosphate-phosphorus. Yearly average concentrations vs river mile (Figure 13) indicates that nitrate-nitrogen concentration increased from river mile 734.5 to 38.9 but exceeded the critical level (based on a yearly average) only at river mile 292.0. The high nitrate-nitrogen level observed at river mile 292.0 reflects the impact of the Snake, Yakima, and Walla Walla Rivers.

Quarterly average concentrations of nitrate-nitrogen vs river mile (Figures 15 and 16) show that a dramatic change in the profile of the Columbia River took place from quarter two to quarter three (Spring to Summer). During quarters one and two (Winter and Spring) the nitrate-nitrogen concentrations generally increased between river miles 734.5 and 38.9 reaching a maximum at river mile 292.0 (See figure 15). During this period, the nitrate-nitrogen concentrations generally exceeded the critical level (0.3 mg/l) between river miles 292.0 and 38.9. The increasing trend observed for quarters one and two did not occur during quarter three (Figure 16). During this period, nitrate-nitrogen concentrations averaged substantially lower than the critical level. Quarter four had a nitrate-nitrogen profile similar to quarters one and two but at a much lower level. In fact, like quarter three, average concentrations did not exceed the critical level.

| Stations | | Nitrate - Nitrogen | | | Orthophosphorus | | |
|---|---|---|---|---|---|---|---|
| Columbia River Tributary | Station | No. Samples | No. >.3 mg/l | Mean (mg/l) | No. Samples | No. > 0.01 mg/l | Mean (mg/l) |
| Mile 734.5 | 61A070 | 17 | 1 | 0.12 | 19 | 15 | 0.020 |
| Kettle R. | 60A070 | 17 | 0 | 0.06 | 17 | 5 | 0.004 |
| Colville R. | 59A070 | 16 | 4 | 0.22 | 17 | 17 | 0.026 |
| Spokane R. | 54A070 | 22 | 12 | 0.36 | 24 | 18 | 0.028 |
| Sanpoil R. | 52A070 | 19 | 0 | 0.07 | 19 | 18 | 0.020 |
| Mile 596.4 | 53A070 | 22 | 1 | 0.14 | 22 | 18 | 0.014 |
| Okanogan R. | 49A070 | 18 | 0 | 0.08 | 18 | 7 | 0.004 |
| Methow R. | 48A070 | 19 | 7 | 0.23 | 21 | 3 | 0.001 |
| Chelan R. | 47A070 | 23 | 2 | 0.10 | 23 | 6 | 0.004 |
| Entiat R. | 46A070 | 23 | 4 | 0.20 | 23 | 15 | 0.009 |
| Wenatchee R. | 45A070 | 23 | 3 | 0.20 | 21 | 8 | 0.004 |
| Mile 453.2 | 44A070 | 20 | 1 | 0.18 | 20 | 16 | 0.020 |
| Crab Cr. | 41A070 | 21 | 19 | 1.10 | 21 | 21 | 0.060 |
| Mile 388.1 | COL060 | 21 | 4 | 0.16 | 21 | 17 | 0.014 |
| Yakima R. | 37A090 | 24 | 17 | 0.60 | 24 | 22 | 0.052 |
| Mile 330.0 | 36A055 | 18 | 3 | 0.22 | 15 | 15 | 0.022 |
| Snake R. | 33A070 | 21 | 10 | 0.44 | 21 | 20 | 0.027 |
| Walla Walla R. | 32A070 | 23 | 21 | 0.84 | 21 | 20 | 0.098 |
| Mile 292.0 | 400081 | 23 | 7 | 0.31 | 24 | 20 | 0.028 |
| Umatilla R. | 403052 | 24 | 23 | 0.81 | 23 | 22 | 0.086 |
| John Day R. | 403053 | 24 | 4 | 0.16 | 23 | 18 | 0.041 |
| Mile 215.6 | 403048 | 24 | 8 | 0.26 | 22 | 18 | 0.028 |
| Deschutes R. | 403051 | 24 | 1 | 0.13 | 23 | 23 | 0.057 |
| Mile 191.4 | 403002 | 23 | 8 | 0.24 | 23 | 19 | 0.030 |
| Klickitat R. | 543110 | 24 | 3 | 0.12 | 23 | 23 | 0.035 |
| Hood R. | 403050 | 24 | 1 | 0.15 | 23 | 19 | 0.059 |
| White Salmon R. | 543111 | 24 | 0 | 0.10 | 23 | 22 | 0.024 |
| Mile 145.3 | 400008 | 24 | 7 | 0.21 | 23 | 17 | 0.022 |
| Washougal R. | 543109 | 24 | 2 | 0.17 | 23 | 9 | 0.016 |
| Sandy R. | 403049 | 24 | 3 | 0.13 | 23 | 12 | 0.016 |
| Willamette R. | 403059 | 24 | 15 | 0.39 | 23 | 22 | 0.038 |
| Lewis R. | 270070 | 20 | 4 | 0.13 | 15 | 9 | 0.017 |
| Kalama R. | 27B070 | 24 | 6 | 0.18 | 21 | 18 | 0.015 |
| Mile 66.0 | 25A150 | 12 | 3 | 0.19 | 10 | 8 | 0.028 |
| Mile 53.5 | 400007 | 23 | 9 | 0.26 | 22 | 15 | 0.022 |
| Mile 38.9 | 403010 | 24 | 10 | 0.24 | 23 | 19 | 0.025 |

TABLE 6 - Nutrient Concentrations at Mainstem Stations

Orthophosphate-phosphorus concentrations were observed above the critical level (.01 mg/1) at all mainstem Columbia River stations (Table 6). Yearly average concentrations vs river mile (Figure 14), indicates that the orthophosphate-phosphorus concentration decreased from river mile 734.5 to 388.1, rose rapidly from river mile 388.1 to 292.0, and then decreased from river mile 292.0 to 38.9. The increase in concentration observed between river mile 388.1 to 292.0 reflects the impact of the Snake, Yakima, and Walla Walla Rivers. Average yearly concentrations exceeded the critical level (.01 mg/1) at all mainstem Columbia River stations.

Quarterly average concentrations of orthophosphate-phosphorus vs river mile (Figures 17 and 18) show that a dramatic change in the profile of the Columbia River took place from quarter two to three. During quarters one and two (Figure 17), the orthophosphate-phosphorus profiles were similar to that observed for the yearly average concentrations (Figure 14) with concentrations exceeding the c itical level at all mainstem Columbia River stations. Quarters three and four produced much lower levels than quarters one and two. During quarter three (Figure 18), the orthophosphate-phosphorus concentration was below the detection level from river mile 734.5 to 596.4, increased to .01 mg/1 between river mile 453.2 and 66.0. During this period, the critical level was exceeded at only one station (river mile 38.9). Orthophosphate-phosphorus concentration decreased from .02 mg/1 to .00 mg/1 from river mile 734.5 to 388.1 for quarter four. Below river mile 388.1 the concentration increased to .01 mg/1, maintaining this level at all downstream stations.

During quarter four, the critical level was exceeded at river miles 734.5 and 453.2.

The preceeding discussion is summarized by the following statements:

1. Average nitrate-nitrogen and orthophosphate-phosphorus concentrations greater than the levels considered critical for potential algae bloom problems were observed during the first and second quarters (11-01-71 to 04-30-72) at all Columbia River stations between river mile 292.0 and the mouth. Orthophosphate-phosphorus, however, exceeded critical levels more consistently and to a greater degree than did nitrate-nitrogen.

2. During quarters three and four (72-05-01 to 72-10-31), average nitrate-nitrogen concentrations were not observed in excess of the critical levels at any of the mainstem Columbia River stations. Orthophosphate-phosphorus continued to be at or near its critical level much of the time. From the observed data, nitrate-nitrogen may be assumed to be the limiting nutrient during this period.

The problem of data interpretation is thus manifest at this point. Sphaerotilus and algae problems are known to occur during the months of July, August and September. Yet, the chemical data evaluated in this report indicates that nutrient levels were high enough to support active growth only between November, 1971 and April, 1972. Between May, 1972, and October, 1972, nitrate-nitrogen levels were limiting and orthophosphate-phosphorus levels were at a minimum level. It is highly possible that these declines are the result however, of algal utilization during these last two quarters.

Nitrate-nitrogen and orthophosphate-phosphorus are considered to be nutrient indicator parameters. If present at adequate levels, they

indicate a potential for accelerated biologic 1 growth (algal blooms). This potential may or may not be realized depending on other limiting factors (temperature, micronutrients, metals, etc.).

The nitrate and orthophosphate tests help provide an insight into the algal bloom potential of the system. The two parameters by themselves form only part of the total picture. Other parameters such as micronutrients, temperature and metals should be considered as well. To help complete the picture, it will be necessary to obtain data on nutrient uptake rates and on the quantity of nutrients tied up in the active biomass (both macro and micro). Analyses that may help fill in the apparent data gap are the algal assay, carbon-14 uptake, chlorophyll determination and algal cell counts.

## APPARENT STANDARDS VIOLATIONS

Violations were observed during this study for temperature and total coliforms at several of the Columbia River mainstem stations (Table 5). Six of the eight temperature violations occurred during the dates 72-08-08 to 72-08-10 when the River was in a low flood condition. Total coliform criteria violations occurred at river miles 734.5, 66.0, and 38.9.

### Temperature

The temperature data plotted on Figure 19 suggest that temperature increased during quarters 2,3 and 4 between river miles 734.5 to 73.1 and decreased during quarter 1. Relativly rapid temperature changes occurred between river miles 330.0 to 292.0 and 145.3 to 53.5. Potential influencing factors between river miles 330.0 to 292.0 would be the

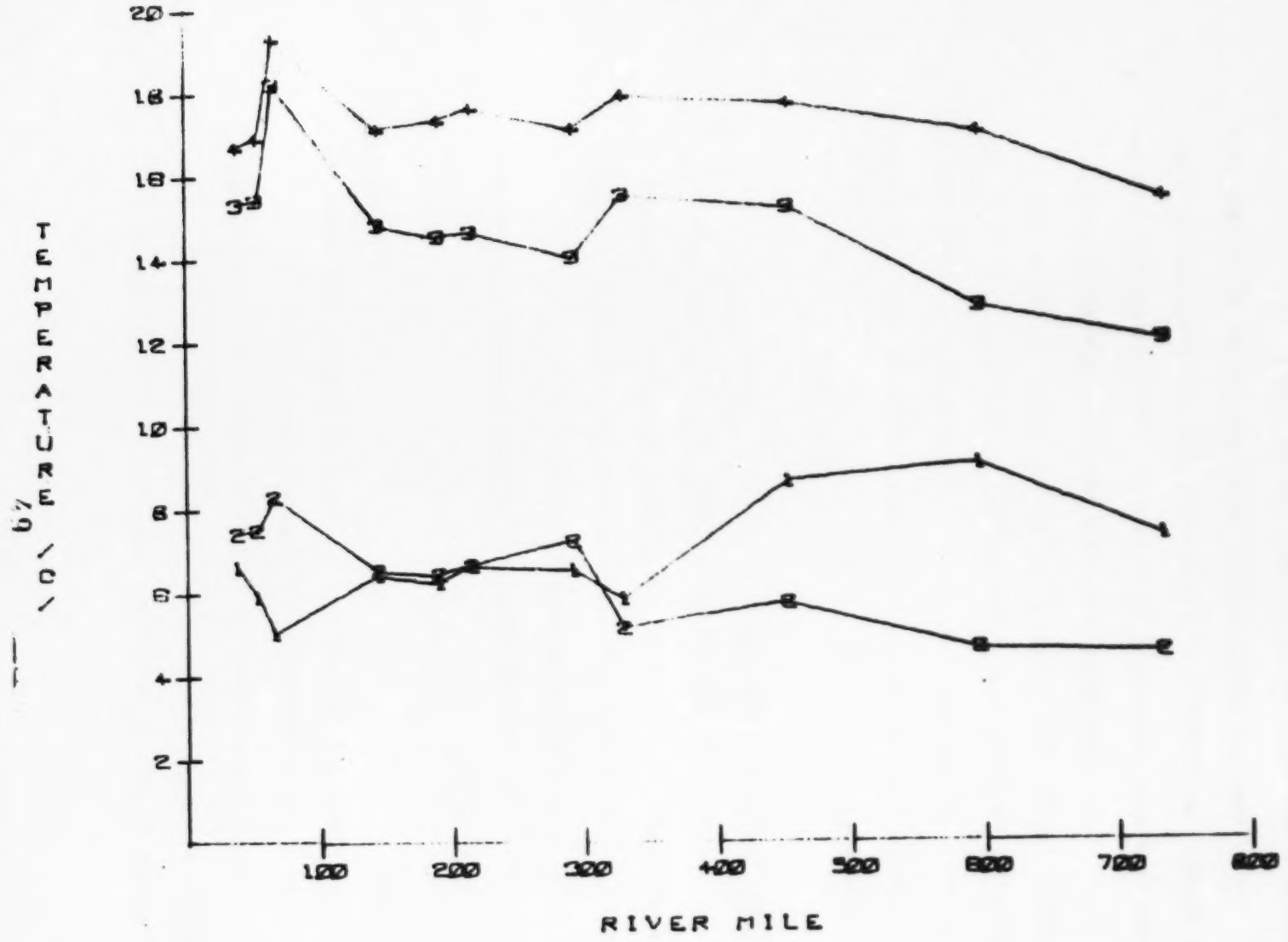


FIGURE 18 QUARTERLY AVG TEMPERATURE OF THE COLUMBIA RIVER

Snake River and McNary Dam. Potential influencing factor between river miles 145.3 to 53.5 would be the Willamette River and the Pacific Ocean.

Total Coliforms

Total coliform levels exceeded water quality standards criteria at three of the eleven Columbia River stations. The standard violations occurred at river miles 734.5, 66.0 and 38.9. In general, total coliform densities were high at river mile 734.5 (near the Canadian border), decreased to a minimum between river miles 330.0 to 214.6, and then increased to a maximum density between river miles 66.0 to 38.9 (Figures 20 and 21).

Although the data in Tables 6 and 7 indicate water quality problems exist, they reveal that few if any of the Columbia River tributaries discharge highly polluted water into the Columbia River.

TABLE 7

WATER QUALITY STANDARDS VIOLATIONS

| Stations Columbia River Tributary | Number | Temperature Samples Total | Temperature Samples Violations* | DO Samples Total | DO Samples Violations* | pH Samples Total | pH Samples Violations* | TOTAL COLIFORMS No. Samples | TOTAL COLIFORMS Median Limit Violation* | TOTAL COLIFORMS Median Limit Value | COLIFORMS Sample Limit Violation* | COLIFORMS Sample Limit Percent |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mile 734.5 | 61A070 | 19 | 2 | 18 | 0 | 2 | 0 | 16 | Yes | 200 | Yes | 44 |
| Kettle R. | 60A070 | 17 | 2 | 16 | 0 | 2 | 0 | 16 | No | 185 | No | 0 |
| Colville R. | 59A070 | 17 | 2 | 16 | 0 | 2 | 0 | 16 | Yes | 550 | No | 19 |
| Spokane R. | 54A070 | 24 | 2 | 22 | 8 | 2 | 0 | 23 | Yes | 350 | Yes | 26 |
| Sanpoil R. | 52A070 | 19 | 3 | 19 | 1 | 2 | 0 | 17 | No | 200 | No | 18 |
| Mile 596.4 | 53A070 | 22 | 0 | 22 | 0 | 2 | 0 | 18 | No | 28 | No | 0 |
| Okanogan R. | 49A070 | 18 | 1 | 18 | 0 | 2 | 0 | 16 | No | 450 | No | 6 |
| Methow R. | 48A070 | 21 | 1 | 21 | 0 | 2 | 0 | 18 | No | 220 | No | 0 |
| Chelan R. | 47A070 | 27 | 4 | 23 | 0 | 1 | 0 | 20 | No | 24 | No | 0 |
| Entiat R. | 46A070 | 23 | 0 | 23 | 0 | 2 | 0 | 20 | Yes | 375 | No | 10 |
| Wenatchee R. | 45A070 | 23 | 0 | 23 | 0 | 2 | 0 | 19 | Yes | 500 | No | 16 |
| Mile 453.2 | 44A070 | 20 | 0 | 20 | 0 | 1 | 0 | 16 | No | 150 | No | 12 |
| Crab Cr. | 41A070 | 21 | 5 | 21 | 0 | 2 | 0 | 19 | No | 1000 | Yes | 21 |
| Mile 388.1 | COL060 | 21 | 0 | 21 | 0 | 21 | 0 | - | - | - | - | - |
| Yakima R. | 37A090 | 24 | 3 | 25 | 0 | 2 | 0 | 24 | Yes | 2150 | Yes | 46 |
| Mile 330.0 | 36A055 | 17 | 0 | 18 | 0 | 0 | 0 | 16 | No | 138 | No | 19 |
| Snake R. | 33A070 | 21 | 4 | 21 | 4 | 2 | 0 | 22 | No | 145 | No | 9 |
| Walla Walla | 32A070 | 24 | 1 | 21 | 0 | 0 | 0 | 24 | Yes | 4800 | Yes | 71 |
| Mile 292.0 | 400081 | 24 | 1 | 24 | 0 | 22 | 0 | 12 | No | 30 | No | 0 |
| Umatilla R. | 403052 | 23 | 5 | 23 | 0 | 21 | 6 | - | - | - | - | - |
| John Day R. | 403053 | 23 | 5 | 23 | 0 | 21 | 3 | - | - | - | - | - |
| Mile 215.6 | 403048 | 23 | 1 | 22 | 0 | 21 | 0 | 12 | No | 21 | No | 0 |
| Deschutes R. | 403051 | 23 | 3 | 23 | 0 | 22 | 2 | - | - | - | - | - |
| Mile 191.4 | 403002 | 23 | 1 | 23 | 0 | 21 | 0 | 13 | No | 140 | No | 8 |
| Klickitat R. | 543110 | 23 | 0 | 23 | 0 | 21 | 1 | 13 | No | 170 | No | 8 |
| Hood R. | 403050 | 23 | 0 | 23 | 0 | 21 | 0 | - | - | - | - | - |
| White Salmon R. | 543111 | 23 | 0 | 23 | 0 | 21 | 0 | 14 | No | 158 | No | 7 |
| Mile 145.3 | 400008 | 24 | 1 | 23 | 0 | 22 | 0 | 13 | No | 90 | No | 0 |
| Washougal R. | 543109 | 24 | 2 | 23 | 0 | 22 | 1 | 12 | No | 98 | No | 17 |
| Sandy R. | 403049 | 23 | 3 | 23 | 1 | 21 | - | - | - | - | - | - |
| Willamette R. | 403059 | 23 | 2 | 23 | 0 | 21 | 1 | 13 | Yes | 3064* | Yes | 38 |
| Lewis R. | 27C070 | 27 | 0 | 27 | 0 | 0 | 0 | 26 | No | 235 | No | 12 |
| Kalama R. | 27B070 | 27 | 1 | 27 | 0 | 0 | 0 | 27 | No | 150 | No | 4 |
| Mile 66.0 | 25A150 | 14 | 1 | 13 | 0 | 0 | 0 | 14 | No | 850 | Yes | 21 |
| Mile 53.5 | 400007 | 23 | 1 | 22 | 0 | 21 | 0 | 11 | No | 700 | No | 18 |
| Mile 38.9 | 403010 | 23 | 1 | 22 | 0 | 21 | 0 | 12 | Yes | 1350 | Yes | 42 |

*Apparent violation

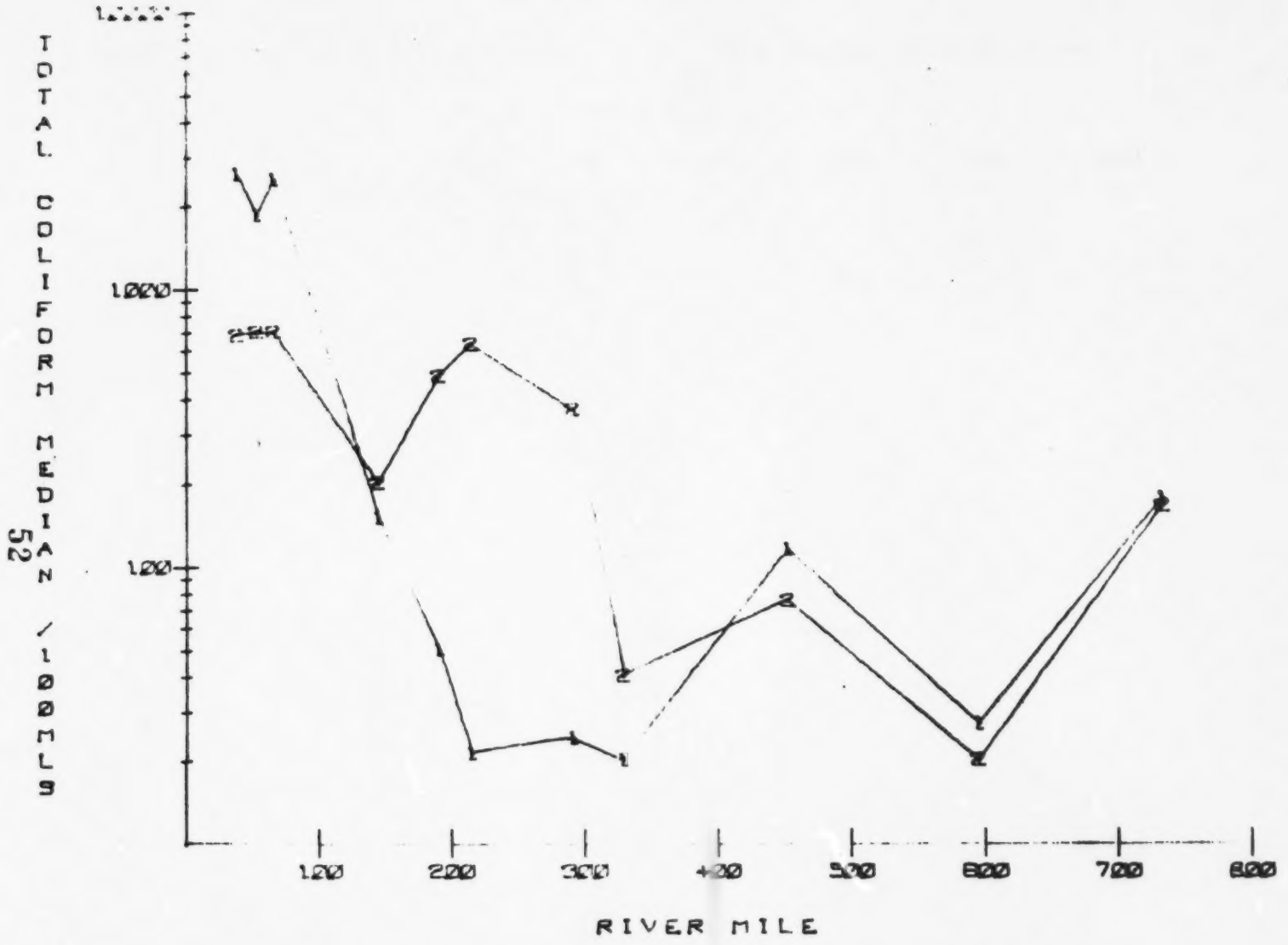


FIGURE 20 QUARTERLY MEDIAN TOTAL COLIFORM DENSITY (QUARTERS 1 AND 2)

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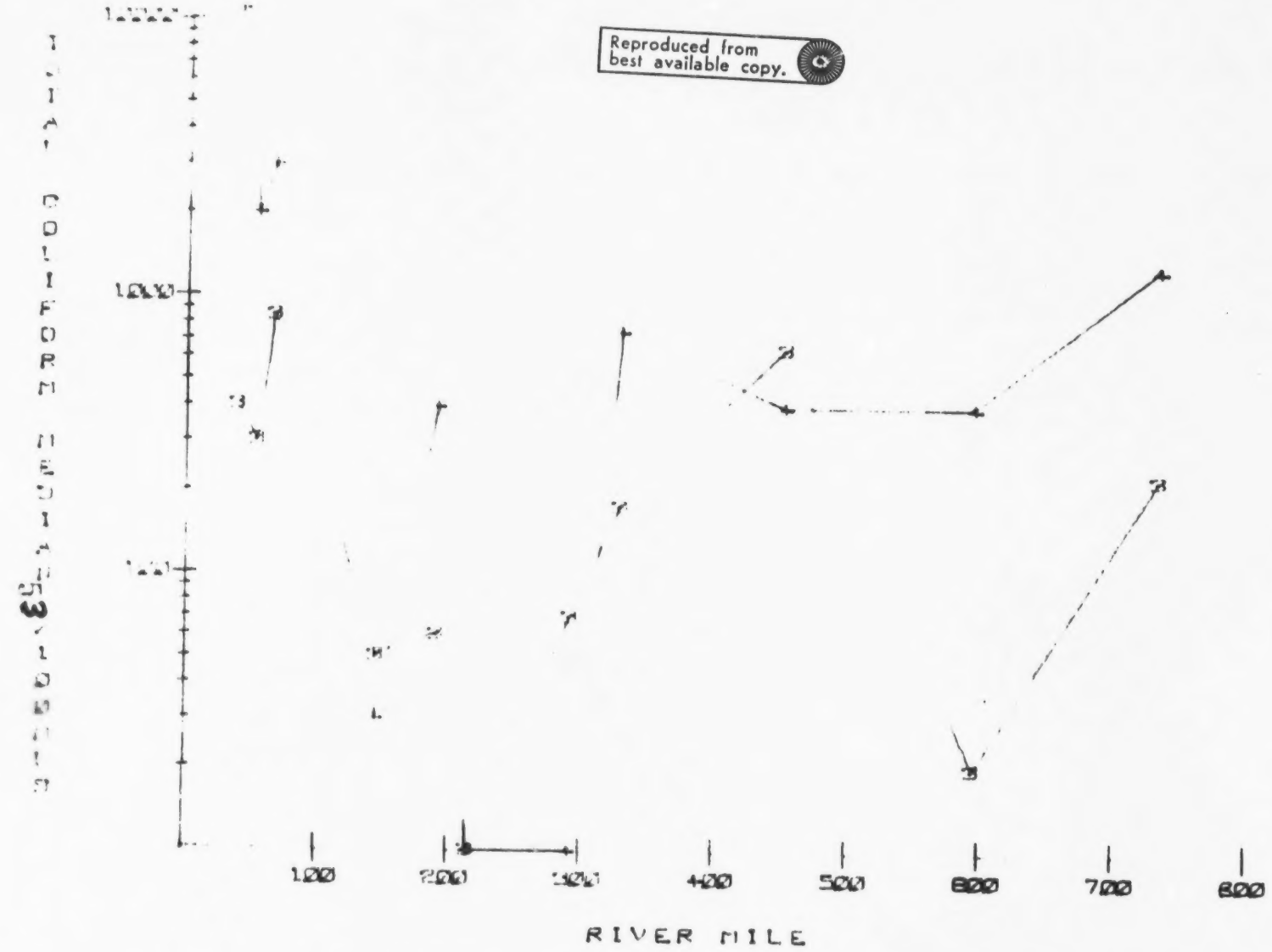


FIGURE 21 QUARTERLY MEDIAN TOTAL COLIFORM DENSITY (QUARTERS 3 AND 4)

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RAW DATA IS AVAILABLE UPON REQUEST FROM

ENVIRONMENTAL PROTECTION AGENCY STORET

# APPENDIX I

## WATER QUALITY CRITERIA

## WATER QUALITY STANDARDS

## WATER QUALITY CRITERIA

Specific criteria for the interpretation of collected water quality data are as follows:

### Water Quality Standards

Promulgated water quality criteria are found in Appendix II. Since the determination of a water quality criterion violation frequently requires a large quantity of data and could require a judicial decision, this report refers to criteria violations as apparent violations. Apparent violations are noted according to the following definitions:

Dissolved Oxygen - A violation is recorded whenever the D.O. (in mg/l or % saturation) drops below the level specified in the standard.

pH - A violation is recorded whenever the pH exceeds the range specified in the standard.

Temperature - A violation is recorded whenever the temperature exceeds the maximum limit specified in the standard (Ex: Class AA = 60 F).

Total Coliform - The coliform standard is applied to the total data collected during the year rather than individual values. A violation is recorded when either the yearly median* value exceeds the limit specified in the standard, or a specific percentage of values exceeds the maximum limit specified in the standard.

* Average value for Oregon rivers.

## Provisional Criteria

Municipal, domestic and other waste water discharges often contain sufficient quantities of nitrogenous and phosphoric compounds to cause increases in the receiving waterways. The following table lists critical parameter levels and the significance of these parameter levels.

Table 1 - CRITICAL WATER QUALITY PARAMETERS

| Substance | Critical Level (mg/l) | Significance |
|---|---|---|
| Nitrate ($NO_3$-N) | .3 | Algae bloom potential |
| Nitrite ($NO_2$-N) | .02 | Organic pollution, low oxygen concentration in stream. |
| Ammonia ($NH_3$-N) | .2 | Organic pollution |
| Ammonia ($NH_3$-N) | 1.0 | Unattractive for fish (toxic) |
| Ortho Phosphate ($O\text{-}PO_4\text{-}P$) | .01 | Algae bloom potential. |

# OREGON WATER QUALITY STANDARDS

## Division 4

## WATER POLLUTION

## SUBDIVISION I

## STANDARDS OF QUALITY FOR PUBLIC WATERS OF OREGON AND DISPOSAL THEREIN OF SEWAGE AND INDUSTRIAL WASTES

ED. NOTE: Unless otherwise specified, sections 41-005 through 41-070 of this chapter of the Oregon Administrative Rules Compilation were adopted by the Sanitary Authority June 1, 1967, and filed with the Secretary of State June 1, 1967 as Administrative Order SA 26. Repeals Administrative Order SA 8.

Statutory Authority: ORS 449.080; 449.086.

NOTE: Effective July 1, 1969, the Sanitary Authority was replaced by the Department of Environmental Quality, consisting of a Department and of a Commission, known as the Environmental Quality Commission. Where Sanitary Authority is presently used in these regulations, it should be noted by readers of these rules that Department of Environmental Quality should be substituted unless the context or statutes clearly require the use of Environmental Quality Commission.

41-005 DEFINITIONS. As used in this subdivision unless otherwise required by context:

(1) "Sewage" means the water-carried human or animal waste

from residences, buildings, industrial establishments or other places together with such ground water infiltration and surface water as may be present. The admixture with sewage as above defined of industrial wastes or wastes, as defined in subsections (2) and (3) of this section, shall also be considered "sewage" within the meaning of this division.

(2) "Industrial waste" means any liquid, gaseous, radioactive or solid waste substance or a combination thereof resulting from any process of industry, manufacturing, trade or business, or from the development or recovery of any natural resources.

(3) "Wastes" means sewage, industrial wastes, and all other liquid, gaseous, solid, radioactive, or other substances which will or may cause pollution or tend to cause pollution of any waters of the state.

(4) "Pollution" means such contamination or other alteration of the physical, chemical or biological properties of any waters of the state, including change in temperature, taste, color, turbidity, silt or odor of the waters, or such discharge of any liquid, gaseous, solid, radioactive or other substance into any waters of the state which either by itself or in connection with any other substance present, will or can reasonably be expected to create a public nuisance or render such waters harmful, detrimental or injurious to public health, safety or welfare, or to domestic, commercial, industrial, agricultural, recreational or other legitimate beneficial uses or to livestock, wildlife, fish or other aquatic life or the habitat thereof.

(5) "Waters of the state" include lakes, bays, ponds, impounding reservoirs, springs, wells, rivers, streams, creeks, estuaries, marshes, inlets, canals, the Pacific Ocean within the territorial limits of the State of Oregon and all other bodies of surface or underground waters, natural or artificial, inland or coastal, fresh or salt, public or private (except those private waters which do not combine or effect a junction with natural surface or underground waters) which are wholly or partially within or bordering the state or within its jurisduction.

(6) "Marine waters" means all oceanic, offshore waters outside of estuaries or bays and within the territorial limits of the state of Oregon.

(7) "Estuarine waters" means all mixed fresh and oceanic waters in estuaries or bays from the point of oceanic water intrusion inland to a line connecting the outermost points of the headlands or protective jetties.

(8) "Standard" or "standards" means such measure of quality or purity for any waters in relation to their reasonable and necessary use as may be established by the Sanitary Authority pursuant to ORS Chapter 449.

(9) "Fish and other aquatic life" means all beneficial fishes, crustacea, mollusks, plankton, higher aquatic plants, and waterfowl.

41-010 HIGHEST AND BEST PRACTICABLE TREATMENT AND CONTROL REQUIRED

Notwithstanding the general and special water quality standards contained in this subdivision, the highest and best practicable treatment and/or control of wastes, activities and flows shall in every case be provided so as to maintain dissolved oxygen and overall water quality at the highest possible levels and water temperatures, coliform bacteria concentrations, dissolved chemical substances, toxic materials, radioactivity, turbidities, color, odor and other deleterious factors at the lowest possible levels.

41-015 RESTRICTIONS ON THE DISCHARGE OF SEWAGE AND INDUSTRIAL WASTES AND HUMAN ACTIVITIES WHICH AFFECT WATER QUALITY IN THE WATERS OF THE STATE

No wastes shall be discharged and no activities shall be conducted such that said wastes or activities either alone or in combination with other wastes or activities will violate or can reasonable be expected to violate, any of the general or special water quality standards contained in this subdivision.

41-020 MAINTENANCE OF STANDARDS OF QUALITY

(1) The degree of waste treatment required to restore and maintain the above standards of quality shall be determined in each instance by the State Sanitary Authority and shall be based upon the following:

(a) The uses which are or may likely be made of the

receiving stream.

(b) The size and nature of flow of the receiving stream.

(c) The quantity and quality of the sewage or wastes to be treated, and

(d) The presence or absence of other sources of pollution on the same watershed.

(2) All sewage shall receive a minimum of secondary treatment or equivalent (equal to at least 85% removal of 5-day biochemical oxygen demand and suspended solids) and shall be effectively disinfected before being discharged into any public waters of the state.

41-025 GENERAL WATER QUALITY STANDARDS

The following General Water Quality Standards shall apply to all waters of the state except where they are clearly superceded by Special Water Quality Standards applicable to specifically designated waters of the state. No wastes shall be discharged and no activities shall be conducted which either alone or in combination with other wastes or activities will cause in any waters of the state:

(1) The dissolved oxygen content of surface waters to be less than six (6) milligrams per liter unless specified otherwise by special standard.

(2) The hydrogen-ion concentration (pH) of the waters to be outside the range of 6.5 to 8.5 unless specified otherwise by special standard.

(3) The liberation of dissolved gases, such as carbon-dioxide, hydrogen sulfide or any other gases, in sufficient quantities to cause objectionable odors or to be deleterious to fish or other aquatic life, navigation, recreation, or other reasonable uses made of such waters.

(4) The development of fungi or other growths having a deleterious effect on stream bottoms, fish or other aquatic life, or which are injurious to health, recreation or industry.

(5) The creation of tastes or odors or toxic or other conditions that are deleterious to fish or other aquatic life or affect the potability of drinking water or the palatibility of fish or shellfish.

(6) The formation of appreciable bottom or sludge deposits or the formation of any organic or inorganic deposits deleterious to fish or other aquatic life or injurious to public health, recreation or industry.

(7) Objectionable discoloration, turbidity, scum, oily sleek or floating solids, or coat the aquatic life with oil films.

(8) Bacterial pollution or other conditions deleterious to waters used for domestic purposes, livestock watering, irrigation, bathing, or shellfish propagation, or be otherwise injurious to public health.

(9) Any measurable increase in temperature when the receiving water temperatures are 64 F. or above, or more than 2 F. increase when receiving water temperatures are 62 F. or less.

(10) Aesthetic conditions offensive to the human senses of sight, taste, smell or touch.

(11) Radioisotope concentrations to exceed Maximum Permissible

Concentrations (MPC's) in drinking water, edible fishes or shellfishes, wildlife, irrigated crops, livestock and dairy products or pose an external radiation hazard.

41-030 BENEFICIAL USES OF WATERS TO BE PROTECTED BY SPECIAL WATER QUALITY STANDARDS.

The Special Water Quality Standards contained in this subdivision are adopted for the purpose of protecting, together with pertinent general water quality standards, the beneficial uses of specified waters of the state as set forth in Table A and to conserve the waste assimilative capacity of the waters so as to accommodate maximum development and utilization of the resources of the state.

41-035 SPECIAL WATER QUALITY STANDARDS FOR PUBLIC WATERS OF GOOSE LAKE IN LAKE COUNTY.

The provisions of this section shall be in addition to and not in lieu of the General Water Quality Standards contained in Section 41-025, except where this section imposes a conflicting requirement with the provisions of Section 41-025, this section shall govern. No wastes shall be discharged and no activities shall be conducted which either alone or in combination with other wastes or activities will cause in the waters of Goose Lake:

(1) Dissolved Oxygen (DO). DO concentrations to be less than 7 milligrams per liter.

(2) Organisms of the Coliform Group Where Associated with Fecal Sources. (MPN or equivalent MF using a representative number of samples). Average concentrations of coliform bacteria to exceed 1000 per 100 ml, with 20% of samples not to exceed 2400 per 100 ml.

(3) Hydrogen-Ion Concentration (pH). pH values to be outside the range of 7.5 to 9.5.

(4) Temperature. Daily average temperatures to exceed 70° F. or the daily mean ambient air temperature, whichever is greater.

41-040 SPECIAL WATER QUALITY STANDARDS FOR PUBLIC WATERS OF THE MAIN STEM KLAMATH RIVER.

The provisions of this section shall be in addition to and not in lieu of the General Water Quality Standards contained in Section 41-025, except where this section imposes a conflicting requirement with the provisions of Section 41-025, this section shall govern. No wastes shall be discharged and no activities shall be conducted which either alone or in combination with other wastes or activities will cause in the waters of the Klamath River:

(1) Dissolved Oxygen (DO).

(a) Main stem Klamath River from Klamath Lake to Keno Regulating Dam located approximately 16 river miles above the Oregon-California border). DO concentrations of surface waters to be less than 5 milligrams per liter unless caused by natural conditions.

(b) (Main stem Klamath River from Keno Regulating Dam to Oregon-California border). DO concentrations to be less than 7 milligrams per liter.

(2) Organisms of the Coliform Group Where Associated with Fecal Sources. (MPN or equivalent MF using a representative number of samples). Average concentrations of coliform bacteria to exceed 1000 per 100 ml, with 20% of samples not to exeeed 2400 per 100 ml.

(3) Turbidity. (Jackson Turbidity Units, JTU). Turbidities to exceed 5 JTU above natural background values except for certain short-term activities which may be specifically authorized by the Sanitary Authority under such conditions as it may prescribe and which are necessary to accommodate essential dredging or construction where turbidities in excess of this standard are unavoidable.

(4) Temperature. Any measurable increase when river temperatures are 72° F. or above, or more than 2° F. cumulative increase when river temperatures are 70° F. or less.

(5) Dissolved Chemical Substances.

Main stem Klamath River at the Oregon-California border. Conductivity to exceed 400 micromhos at 77 F.

(6) Hydrogen-Ion Concentration.

(pH) pH values to be outside the range of 7.0 to 9.0.

41-045 SPECIAL WATER QUALITY STANDARDS FOR THE PUBLIC WATERS OF MULTNOMAH CHANNEL AND THE MAIN STEM WILLAMETTE RIVER.

The provisions of this section shall be in addition to and not in lieu of the General Water Quality Standards contained in Section 41-016, except where this section imposes a conflicting requirement with the provisions of Section 41-016, this section shall govern. No wastes shall be discharged and no activities shall be conducted which either alone or in combination with other wastes or activities will cause in the waters of Multnomah Channel or the Willamette River:

(1) Dissolved Oxygen. (DO).

(a) (Multnomah Channel and main stem Willamette River from mouth to the Willamette Falls at Oregon City, river mile 26.6). DO concentrations to be less than 5 milligrams per liter.

(b) (Main stem Willamette River from the Willamette Falls to Newberg, river mile 50. DO concentrations to be less than 6 milligrams per liter.

(c) (Main stem Willamette River from Newberg to Salem, river mile 85. DO concentrations to be less than 7 milligrams

per liter.

(d) (Main stem Willamette River from Salem to confluence of Coast and Middle Forks, river mile 187). DO concentrations to be less than 90% of saturation.

(2) Organisms of the Coliform Group Where Associated With Fecal Sources. (MPN or equivalent MF using a representative number of samples). Average concentrations of coliform bacteria to exceed 1000 per 100 ml, with 20% of samples not to exceed 2400 per 100 ml.

(3) Turbidity. (Jackson Turbidity Units, JTU). Turbidities to exceed 5 JTU above natural background values except for certain short-term activities which may be specifically authorized by the Sanitary Authority under such conditions as it may prescribe and which are necessary to accommodate essential dredging or construction where turbidities in excess of this standard are unavoidable.

(4) Temperature.

(a) (Multnomah Channel and main stem Willamette River from mouth to Newberg, river mile 50). Any measurable increase when river temperatures are 70° F. or above, or more than 2° F. increase when river temperatures are 68° F. or less.

(b) Main stem Willamette River from Newberg to confluence of Coast and Middle Forks, river mile 187). Any measurable increase when river temperatures are 64° F. or above, or more than 2° F. increase when the river temperatures are 62° F. or less.

(5) Dissolved Chemical Substances. Guide concentrations listed below to be exceeded except as may be specifically authorized by the Sanitary Authority upon such conditions as it may deem necessary to carry out the general intent of Section 41-010 of this subdivision and to protect the beneficial uses set forth in Table A.

| | mg/l |
|---|---|
| Arsenic (As) | 0.01 |
| Barium (Ba) | 1.0 |
| Boron (Bo) | 0.5 |
| Cadmium (Cd) | 0.01 |
| Chloride (Cl) | 25. |
| Chromium (Cr) | 0.05 |
| Copper (Cu) | 0.005 |
| Cyanide (CN) | 0.01 |
| Fluoride (F) | 1.0 |
| Iron (Fe) | 0.1 |
| Lead (Pb) | 0.05 |
| Manganese (Mn) | 0.05 |
| Phenols (totals) | 0.001 |
| Total dissolved solids | 100. |
| Zinc (Zn) | 0.1 |
| Heavy metals (Totals including Cu, Pb, Zn, and others of non-specific designation) | 0.5 |

41-050 SPECIAL WATER QUALITY STANDARDS FOR THE PUBLIC WATERS OF THE MAIN STEM OF THE COLUMBIA RIVER FROM THE EASTERN OREGON-WASHINGTON BORDER WESTWARD TO THE PACIFIC OCEAN.

The provisions of this section shall be in addition to and not in lieu of the General Water Quality Standards contained in Section 41-025, except where this section imposes a conflicting requirement with the provisions of Section 41-025, this section shall govern. No wastes shall be discharged and no activities

shall be conducted which either alone or in combination with other wastes or activities will cause in the waters of the Columbia River:

(1) Dissolved Oxygen. (DO) DO concentrations to be less than 90% of saturation.

(2) Organisms of the Coliform Group Where Associated With Fecal Sources. (MPN or equivalent MF using a representative number of samples).

(a) (From the eastern Oregon-Washington boundary downstream to the Interstate Highway 5 bridge between Vancouver, Washington and Portland, Oregon). Average concentrations of coliform bacteria to exceed 240 per 100 milliliters or to exceed this value in more than 20 percent of the samples.

(b) From the Interstate Highway 5 bridge between Vancouver, Washington and Portland, Oregon, to the mouth). Average concentrations of coliform bacteria to exceed 1000 per 100 milliliters, with 20 percent of the samples not to exceed 2400 per 100 milliliters.

(3) Turbidity. (Jackson Turbidity Units, JTU). Turbidities to exceed 5 JTU above natural background values except for certain short-term activities which may be specifically authorized by the Sanitary Authority under such conditions as it may prescribe and which are necessary to accommodate essential dredging or construction where turbidities in excess of this standard are unavoidable.

(4) Hydrogen-Ion Concentration pH values to fall outside the range of 7.0 to 8.5.

(5) Temperature. Any measurable increase when river temperatures are 68° F. or above, or more than 2° F. increase when river temperatures are 66° F. or less.

(6) Dissolved Chemical Substances. (Above the zone of marine water intrusion, approximate river mile 40). Guide concentrations listed below to be exceeded except as may be specifically authorized by the Sanitary Authority upon such conditions as it may deem necessary to carry out the general intent of Section 41-010 of this subdivision and to protect the beneficial uses set forth in Table A.

| | mg/l |
|---|---|
| Arsenic (As) | 0.01 |
| Barium (Ba) | 1.0 |
| Boron (Bo) | 0.5 |
| Cadmium (Cd) | 0.01 |
| Chloride (Cl) | 30. |
| Chromium (Cr) | 0.05 |
| Copper (Cu) | 0.005 |
| Cyanide (CN) | 0.01 |
| Fluoride (F) | 1.0 |
| Iron (Fe) | 0.1 |
| Lead (Pb) | 0.05 |
| Manganese (Mn) | 0.05 |
| Phenols (totals) | 0.001 |
| Total dissolved solids | 200. |
| Zinc (Zn) | 0.1 |
| Heavy metals (Totals including Cu, Pb, Zn, and others of non-specific designation) | 0.5 |

## 41-105 SPECIAL WATER QUALITY AND WASTE TREATMENT STANDARDS FOR THE DESCHUTES RIVER BASIN.

The provisions of these sections shall be in addition to, and not in lieu of, existing STANDARDS OF QUALITY FOR PUBLIC WATERS OF OREGON AND DISPOSAL THEREIN OF SEWAGE AND INDUSTRIAL WASTES (Oregon Administrative Rules, Chapter 340, Division 4, Subdivision 1). Where these sections impose conflicting requirements with the provisions of Section 41-025, these sections shall govern.

Special Water Quality Standards. No wastes shall be discharged and no activities shall be conducted which either alone or in conjunction with other wastes or activities will cause in the waters of the Deschutes River Basin:

(1) Organisms of the Coliform Group where associated with fecal sources. (MPN or equivalent MF using a representative number of samples). To exceed an average concentration of 240 per 100 milliliters, except during periods of high runoff.

(2) Dissolved Oxygen (DO). Dissolved oxygen concentrations to be less than 90 percent of saturation at the seasonal low, or less than 95 percent of saturation in spawning areas during spawning, incubation, hatching, and fry stages of salmonid fishes.

(3) pH (Hydrogen-Ion Concentration). pH values to fall outside the range of 7.0 to 8.5.

(4) Turbidity (Jackson Turbidity Units, JTU). Any measurable increases in natural stream turbidities when natural stream turbidities are less than 30 JTU, or more than a 10 percent cumulative increase in natural stream turbidities when stream turbidities are more than 30 JTU, except for certain short-term activities which may be specifically authorized by the Department of Environmental Quality under such conditions as it may prescribe and which are necessary to accommodate essential dredging, construction, or other legitimate uses or activities where turbidities in excess of this standard are unavoidable.

(5) Temperature. Any measurable increases when stream temperatures are 58° F. or above, or more than 2° F. increases when stream temperatures are 56° F. or less, except for certain short-term activities which may be specifically authorized by the Department of Environmental Quality under such conditions as it may prescribe and which are necessary to accommodate legitimate uses or activities where temperatures in excess of this standard are unavoidable.

Minimum standards for Treatment and Control of Wastes. Prior to discharge or release to the public waters of the Deschutes River Basin all wastes shall be treated or controlled in accordance with the following:

(1) Sewage.

(a) For the Metolius River subbasin and the Deschutes River Basin above the Bend Diversion Dam (River Mile 165), average effluent concentrations shall not exceed 5 milligrams per liter of 5-day 20° C. Biochemical Oxygen Demand (BOD) and 5 milligrams per liter of suspended solids (SS).

(b) For the Deschutes River from the Bend Diversion Dam (RM 165) downstream to the Pelton Reregulating Dam (RM 100) and for the Crooked River subbasin, average effluent concentrations shall not exceed 10 milligrams per liter of 5-day 20° C. Biochemical Oxygen Demand (BOD) and 10 milligrams per liter of suspended solids (SS).

(c) For the Deschutes River from the Pelton Reregulating Dam (RM 100) downstream to its mouth, average effluent concentrations shall not exceed 20 milligrams per liter of 5-day 20° C. Biochemical Oxygen Demand (BOD) and 20 milligrams per liter suspended solids (SS).

(d) The treatment standards in item 1 (a) above. applicable to the Metolius River subbasin and the Upper Deschutes River basin, shall apply year round. Treatment standards in 1 (b) and 1 (c) above, applicable to the Crooked River subbasin and the middle and lower Deschutes River, shall apply during the warm weather season, approximately April 1 to October 31, and all treatment and control facilities shall be operated at maximum efficiency so as to

minimize waste discharges to public waters during the cold weather season, approximately November 1 to March 31.

(e) All sewage wastes shall be disinfected, after treatment, equivalent to thorough mixing with sufficient chlorine to provide a residual of at least 1 part per million after 60 minutes of contact time.

(f) Positive protection shall be provided to prevent bypassing raw or inadequately treated sewage to any public waters.

(g) More stringent waste treatment and control requirements may be imposed, especially in headwater and tributary streams, where waste loads may be large relative to stream flows.

(2) Industrial and Agricultural Wastes. Industrial and agricultural waste treatment or control requirements shall be determined on an individual basis in accordance with the provisions of Sections 41-010, 41-015, 41-020, 41-025 and 41-030 of Oregon Administrative Rules, Chapter 340.

(a) Where industrial or agricultural effluents contain significant quantities of potentially toxic elements, treatment requirements shall be determined utilizing appropriate bioassays.

(3) General. All persons proposing developments within the Deschutes River Basin shall fully explore, with the aid of competent engineering assistance, all feasible alternative

methods of waste disposal. First consideration shall be given to systems which have no direct discharges to surface waters, and in every case installation of a system shall be required which will provide not only adequate protection but the best possible protection of the overall environmental quality of the area.

Hist: Filed 33-3-70 as DEQ 4.

State of
Washington
Department
of Ecology

# WATER QUALITY STANDARDS

## JUNE 19, 1973

Daniel J. Evans, *Governor* John A. Biggs, *Director* Olympia, Washington 98504 Telephone (206) 753-2800

(23) Columbia River from mouth to the Washington-Oregon border (river mile 309). Special condition - temperature - water temperatures shall not exceed 68° F. due in part to measurable (0.5° F.) increases resulting from human activities; nor shall such temperature increases, at any time, exceed 2° F. due to all such activities combined. Dissolved oxygen shall exceed 90% of saturation. Below interstate highway No. 5 bridge. Total coliform organisms shall not exceed median values of 1,000 with less than 20% of samples exceeding 2,400 when associated with any fecal source. Class A

(24) Columbia river from Washington - Oregon border (river mile 309) to Grand Coulee Dam (river mile 595). Special condition from Washington-Oregon border (river mile 309) to Priest Rapids Dam (river mile 397). Temperature - water temperatures shall not exceed 68° F. due in part to measurable (0.5° F.) increases resulting from human activities; nor shall such temperature increases, at any time, exceed t = 110/(T-15); for purposes hereof, "t" represents the permissive increase and "T" represents the water temperature due to all causes combined. Class A

(25) Columbia River from Grand Coulee Dam (river mile 595) to Canadian border (river mile 742). Class AA

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NEW WAC 173-201-030 --------GENERAL WATER USE AND CRITERIA CLASSES. The following criteria shall be applicable to the various classes of waters in the State of Washington:

(1) Class AA (Extraordinary).

(a) General characteristic. Water quality of this class shall markedly and uniformly exceed the requirements for all or substantially all uses.

(b) Characteristic uses. Characteristic uses shall include, but are not limited to the following:

(i) Water supply (domestic, industrial, agricultural).

(ii) Wildlife habitat, stock watering.

(iii) General recreation and aesthetic enjoyment (picnicking, hiking, fishing, swimming, skiing, and boating).

(iv) General marine recreation and navigation.

(v) Fish and shellfish reproduction, rearing, and harvest.

(c) Water quality criteria.

(i) Total coliform organisms shall not exceed median values of 50 (fresh water) or 70 (marine water) with less than 10% of samples exceeding 230 when associated with any fecal source.

(ii) Dissolved oxygen shall exceed 9.5 mg/l (fresh water) or 7.0 mg/l (marine water).

(iii) Total dissolved gas - the concentration of total dissolved gas shall not exceed 110% of saturation at any point of sample collection.

(iv) Temperature - water temperatures shall not exceed 60° F. (fresh water) or 55° F. (marine water) due in part to measurable (0.5° F.) increases resulting from human activities; nor shall such temperature increases, at any time, exceed $t = 75/(T-22)$ (fresh water) or $t = 24/(T-39)$ (marine water); for purposes hereof "t" represents the permissive increase and "T" represents the water temperature due to all causes combined.

(v) pH shall be within the range of 6.5 to 8.5 (fresh water) or 7.0 to 8.5 (marine water) with an induced variation of less than 0.1 units.

(vi) Turbidity shall not exceed 5 JTU over natural conditions.

(vii) Toxic, radioactive, or deleterious material concentrations shall be less than those which may affect public health, the natural aquatic environment, or the desirability of the water for any usage.

(viii) Aesthetic values shall not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch

2.

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(2) Class A (Excellent).

(a) General characteristic. Water quality of this class shall meet or exceed the requirements for all or substantially all uses.

(b) Characteristic uses. Characteristic uses shall include, but are not limited to, the following:

(i) Water supply (domestic, industrial, agricultural).

(ii) Wildlife habitat, stock watering.

(iii) General recreation and aesthetic enjoyment (picnicking, hiking, fishing, swimming, skiing and boating).

(iv) Commerce and navigation.

(v) Fish and shellfish reproduction, rearing and harvest.

(c) Water quality criteria.

(i) Total coliform organisms shall not exceed median value of 240 (fresh water) with less than 20% of samples exceeding 1,000 when associated with any fecal sources or 70 (marine water) with less than 10% of samples exceeding 230 when associated with any fecal sources.

(ii) Dissolved oxygen shall exceed 8.0 mg/l (fresh water) or 6.0 mg/l (marine water).

(iii) Total dissolved gas - the concentration of total dissolved gas shall not exceed 110% of saturation at any point of sample collection.

(iv) Temperature - water temperatures shall not exceed 65° F. (fresh water) or 61° F. (marine water) due in part to measurable (0.5° F.) increases resulting from human activities; nor shall such temperature increases, at any time, exceed $t = 90/(T-19)$ (fresh water) or $t = 40/(T-35)$ (marine water); for purposes hereof "t" represents the permissive increase and "T" represents the water temperature due to all causes combined.

(v) pH shall be within the range of 6.5 to 8.5 (fresh water) or 7.0 to 8.5 (marine water) with an induced variation of less than 0.25 units.

(vi) Turbidity shall not exceed 5 JTU over natural conditions.

(vii) Toxic, radioactive, or deleterious material concentrations shall be below those of public health significance, or which may cause acute or chronic toxic conditions to the aquatic biota, or which may adversely affect any water use.

(viii) Aesthetic values shall not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch, or taste.

(3) Class B (Good).

(a) General characteristic. Water quality of this class shall meet or exceed the requirements for most uses.

(b) Characteristic uses. Characteristic uses shall include, but are not limited to, the following:

(i) Industrial and agricultural water supply.

(ii) Fishery and wildlife habitat.

(iii) General recreation and aesthetic enjoyment (picnicking, hiking, fishing, and boating).

(iv) Stock watering.

(v) Commerce and navigation.

(vi) Shellfish reproduction and rearing, and crustacea (crabs, shrimp, etc.) harvest.

(c) Water quality criteria.

(i) Total coliform organisms shall not exceed median values of 1,000 with less than 10% of samples exceeding 2,400 when associated with any fecal source.

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